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A Strategic Approach to Strengthening International Competitiveness in Knowledge Based Industries: Non-electrical Machinery Industry

M. Padma Suresh*

Abstract: This study examines some major issues regarding competitiveness in one of the medium-high technology industries namely non-electrical machinery industry. Besides a review of the evolution and structure of the industry, the growth performance of the component industries is examined at the three-digit ASI level. A detailed analysis of exports as well as imports at the four-digit ITC classification is undertaken to examine the impact of liberalisation on specific machinery categories. The study indicates the inward orientation of the industry. Low tariffs and liberal imports including imports of second hand machinery have affected some industries like textile machinery and machine tools. The study considers two specific issues that are important for establishing export competitiveness namely developing technological capability and FDI in the industry. A case study of machine tool industry is incorporated for a better understanding of these issues. The report concludes with suggestions for strengthening competitiveness in the industry.

1. Introduction

Since the 1990s with the rapid pace of liberalization and integration with the world market, developing countries are faced with intense competitive pressures. In India, reforms that began in the mid-1980s gained momentum in the 1990s with major changes in trade and industrial policies leading to a significantly changed environment for firms.

A number of empirical studies have examined the impact of liberalization on the manufacturing sector in general while the performance of the capital

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goods sector in particular has also been the focus of some of the studies (Mani,1998;Nagraj,2002,2003; Balakrishnan and Suresh Babu,2003). The non-electrical machinery industry is a part of the capital goods sector, which was one of the first sectors to undergo reforms in India. It has been suggested that this sector has been severely affected since mid-1990s with liberalization measures like reduction in tariff rates and liberal imports of second hand machinery leading to the collapse of the machine building industry (Desai,2001). The reasons for such apprehensions relate to the relative competitiveness of the domestic machinery sector in the liberalized environment given that the growth of the industry in post independent India has been in protected monopolistic/ oligopolistic markets and the predominant role of the public sector in the industry. The specific technological characteristics of the industry also raise doubts about the ability to develop capability to compete in the context of liberalization.

This study examines some major issues relating to competitiveness in the non-electrical machinery industry[1] in the context of liberalization. Section 2 briefly looks at some major issues concerning competitiveness in the industry with the focus on technology related issues. Section 3 includes a description of the evolution and structure of the industry as well as broad policy measures relating to liberalization that have affected the industry. Section 4 examines the growth performance of the industry at the three digit ASI level for the period 1980-81to 1997-98. A detailed analysis of exports and imports in the industry since 1990-91 at the four digit ITC classification for categories broadly corresponding to three digit ASI categories of non-electrical machinery is made to examine the impact of liberalization on specific categories. Section 5 looks at major issues for competitiveness relating to technology development and role of foreign direct investment(FDI) in the industry. Section 6 is a case study of competitiveness in the machine tool industry and is based on primary survey data supplemented by secondary data. Section 7 includes a summary of the broad conclusions and incorporates policy suggestions for a strategic approach to strengthening competitiveness in the non-electrical machinery industry.

2. Competitiveness in Non-electrical Machinery Industry-Some Issues

Traditional literature explained international specialization based on comparative advantage namely that countries tend to specialize in industries, which intensively use their cheap and/or abundant factors of production. The non-electrical machinery industry is a medium-high technology industry that

is capital intensive and is characterised by technological sophistication. It is therefore expected that industrialised countries with higher endowments of capital and technological advantages in the production of machinery would be expected to perform well in this industry in terms of exports. In fact, five developed nations - the United States, Germany, Japan, Italy and United Kingdom- account for more than 58 per cent of exports in non-electrical machinery sector[2]. Although there is evidence that India is moving away from resource based products to technology based products in the post liberalisation period (Kumar and Pradhan,2003a), the contribution of the non-electrical machinery sector to exports has not been significant and was less than 4 per cent in 2000-01. India's share in world exports of machinery is less than 1 per cent (Economic Survey, GOI, 1995-96).

The non-electrical machinery industry as it has evolved in India has been inward oriented with exports of this industry being insignificant. The domestic market has been the main focus for this industry and the state has been a major consumer of products of this industry. On the other hand, imports in certain industries like machine tools and textile machinery have increased significantly in the liberalized regime. The focus of the present study is to examine the major issues regarding competitiveness in the industry by highlighting two aspects relating to developing capability in the sector- namely technology aspects and the role of FDI.

The non-electrical machinery industry produces a range of durable machinery, equipment, spares and accessories for a wide cross-section of user segments in agriculture, chemical, automobile, petrochemical, fertiliser, textiles, mining, construction, power, defence etc. The industry is characterised by fairly complex technology that necessitates high levels of R&D and skill Also since capital requirements are large and there exist strong learning effects in operation; barriers to entry are typically high in machinery manufacturing. To compete in international markets, machinery manufacturers need to emphasise on product design and development. Producing for an export market requires technological capabilities to meet stringent international standards in quality and is therefore much more difficult than supplying to the domestic market. Hence technology development has an important role to play in establishing export competitiveness. It is generally argued that the incentive for technological development in the domestic industry was lacking in the initial decades of the import substituting industrialization (ISI) phase. But with greater competitive pressures since liberalization it is expected that firms in the industry would increasingly try to access and adopt new technologies.

Another technological characteristic of non-electrical machinery industry is that the supply of machinery necessitates continuous close links with user industries to understand specific user industry requirements of machinery as well as for installation and commissioning and for the supply of spare parts, servicing, repairs etc. Supplying to overseas markets therefore present major problems to exporters in developing countries in establishing and developing strong marketing/distribution networks. The role of FDI is therefore considered important as it not only leads to increased access to technology through joint ventures and licensing but also makes possible an enhanced knowledge of international market conditions and provides access to overseas marketing networks. It is in this context as well as that of liberalization that the role of FDI and technological development has been considered important in explaining export performance of developing countries especially in high technology products(Kumar and Pradhan,2003b).

3. Non-electrical Machinery- Evolution, Structure and Policy

Evolution and Structure: The evolution of the non-electrical machinery industry, which is part of the capital goods sector, can be seen in the context of the adoption of the import substituting industrialization strategy in the second five-year plan. This strategy assigned an important role to the state in promoting investments in this sector. Private capital supplemented the state effort in this industry and was provided a protected environment to enable its growth. By the early 1970s, India achieved the capability to produce almost the entire range of non-electrical machinery needed for the domestic industry. Since establishing a manufacturing capacity in heavy equipment and machinery was crucial to a self-reliant industrialization strategy, investments made in this industry were not necessarily determined by long term comparative strengths or advantages but were aimed at acquiring self-sufficiency.

The establishment of public sector enterprises (PSEs) like Hindustan Machine Tools (HMT), Heavy Engineering Corporation (HEC), Bharat Earth Movers Ltd. (BEML), Bharat Heavy Electricals Ltd. (BHEL) Bharat Heavy Plates & Vessels (BHPV) etc. from the 1950s onwards was aimed at achieving self sufficiency in the manufacture of heavy machinery and for establishing a strong capital base. These public sector enterprises were thus engaged in the manufacture of engineering equipment like construction and mining equipment, chemical machinery, agricultural machinery, machine tools etc. The establishment of these industries facilitated the further expansion of the industrial sector as the PSEs were in turn closely linked to user industries like

steel and fertiliser plants, railways, defence establishments etc. The state was thus an important investor as well as a consumer of capital goods and the technical expertise and know-how for setting up of these PSEs was initially largely acquired from the (erstwhile) USSR and East European countries.

The market structure in the non-electrical machinery industry is one, which is dominated by PSEs like HMT, HEC, BEML, BHEL etc. in heavy engineering like machine tools, earth moving machinery, prime movers and boilers. In other cases like textile, dairy, cement, chemical machinery etc it is the private sector that is predominant. Firms in these industries operated in a protected environment in monopolistic markets and many of the firms had technological collaborations with foreign firms for import of technology with emphasis on domestic development of technology in the industry being insignificant. In many of the component industries of non-electrical machinery, a few large firms account for bulk of the output. These large firms are multi-product engineering companies in both the private and public sector (like HMT, HEC, BEML, L&T, Alfa Laval, Lakshmi Machine Works(LMW), Texmaco, Kirloskar Group Companies etc). For example in cement machinery some major firms which account for the bulk of output are- Fuller India, L&T, KCP and Cimmco Birla; in sugar machinery KCP, Texmaco, etc.; in chemical machinery- Alfa Laval, L&T, BHVP, Godrej and Boyce Manufg. Co.etc; in construction and mining machinery-BEML, Mining and Allied Machinery, L&T, Escorts etc; in food and dairy machinery-HMT, Alfa Laval, L&T etc; in textile machinery-LMW, Kunal Engg besides other Lakshmi Group companies; in machine tools –HMT, Widia, ACE Designers, LMW, HEC etc; in pumps and compressors-BHEL, Bharat Pumps and Compressors Ltd, Kirloskar Group companies, etc. Besides the PSEs and the large private sector companies there are also small and medium enterprises which are engaged in the manufacture of small machinery and parts, components and accessories.

The Policy Framework: Since the 1980s the literature on industrial performance had increasingly highlighted the fact that industrial growth was hampered by the multitude of regulations and controls which were in place (Ahluwalia,1985). The apparent outcomes of such regulation took the form of uneconomic scale of production, underutilization of capacity and lack of technological dynamism. High tariff walls and strict import licensing by restricting competition had produced a domestic cost structure in India, which was out of line with world prices, and therefore uncompetetive and where the incentive for technological modernisation was absent. In a series of important

policy measures, the process of reforms was initiated in the 1980s and given further momentum in the 1990s(Kumar,2000; Basant,2000).

In 1985, there was further delicensing of 25 broad groups of industries including several items of industrial machinery for non-MRTP and non-FERA companies.(e.g. rubber, printing, footwear machinery, agricultural implements etc). Broad banding to enable changes in product mix was extended to about 28 industry groups(metallurgical machinery, chemical, pharmaceutical and fertiliser machinery, machine tools, agricultural machinery, earth moving machinery, metal handling equipment etc.) while capacity reendorsement facility was given to a large number of industries to accelerate modernisation.

The reforms undertaken in the 1980s led to rapid expansion of industrial activity and further policy initiatives were announced in the new industrial policy of 1991, substantially deregulating the industrial sector and liberalizing foreign investment and technology imports. Similarly reforms in trade policy aimed at substantial liberalisation of controls and licences, decanalisation of many items of trade, reduction in peak tariff rates, exchange rate adjustments and other measures to encourage competitiveness in the economy. In order to meet the requirements of machinery for modernisation of export production a large number of items (initially 201) of industrial machinery have been included in the list of capital goods allowed for imports under OGL. Also, in the initial stages of reforms, the capital goods sector including non-electrical machinery was subjected to the fastest tariff reductions. Customs tariffs were reduced from a peak of over 300 per cent in 1991 to a peak rate of 50 per cent by 1995 and further to 25 per cent in 2003. The import duty on capital goods for general projects and machinery which was 85 per cent prior to reforms was brought down to 25 per cent in 1995 and unified for nearly four-fifths of machinery. Project imports of capital goods for World Bank, ADB and other international projects as well as for oil and gas projects carry a zero per cent duty. In addition, project imports for fertiliser, power, coal mining and refinery projects carry only a five per cent duty.

Imports of second hand machinery have also been liberalised and the initial age limit requirement of capital goods not being more than seven years old has been relaxed. The minimum residual life of the machinery, however, should be five years. In the case of imports of many textile machinery items like those for garments, hosiery and made-ups as well as leather processing machinery a licence is not required.

Major changes in import licensing were made by replacing a large part of administered licensing of imports by import entitlements linked to export earnings. The import replenishment system was enlarged and restructured and renamed as EXIM scrips. Additional eximscrips entitlement was permitted for import of high technological engineering products. The government has also introduced a Special Import Licence Scheme for manufacturers who have acquired prescribed quality standards. Export credit schemes like the EPCG Scheme have been liberalised and the five year Foreign Trade Policy announced in 2004 has further liberalised norms for import of capital goods. Under the EPCG scheme duty free imports of capital goods are permitted for export of agri-products. A major change in the EPCG scheme is the relaxation in age restriction of ten years on import of second hand capital goods. Domestic capital goods industry is therefore under greater pressure now.(Economic Times, 1st September, 2004)

Thus, removal of quantitative restrictions, tariff reductions and liberal second hand imports have affected the non-electrical machinery industry, with imports of capital goods increasing in the post liberalisation phase. While imports of capital goods including machinery were liberalised to enable modernisation of domestic user industries it is argued that this has adversely affected the domestic machinery sector(Desai, 2001). We now examine the impact of these reforms on the industry.

4. Output Growth, Exports and Imports in Non-electrical Machinery Industry

The share of non-electrical machinery in the value of output in registered manufacturing (at 1993-94 prices) increased from 2.1 per cent in 1955-56 to 6 per cent in 1973-74 and 6.8 per cent in 1980-81 but has since decreased in the 1990s. In 1999-00 the share of the industry was 6 per cent. In 1997-98 the share of non-electrical machinery was 4.8 per cent - the same as its share in 1965-66[3].

The non-electrical machinery industry comprises various component industries which manufacture agricultural machinery, construction, mining and quarrying equipment, prime movers, boilers etc., food and textile machinery, machine tools, lifting and handling equipment and other general as well as special purpose machinery[4]. There are more than 8000 factories registered in this industry which produced machinery and equipment worth Rs.36080 crs in 1997-98. The industry employed 4.5 lakh employees and more than a quarter of the industry is located in Maharashtra. Table 3.1 gives the shares of the ten

component industries of non-electrical machinery industry in output and employees for three years for the ASI[5] three digit classification.

We note that agricultural machinery(350) and prime movers and boilers(352) and general purpose machinery(356) together account for half the share of output(as well as employment) of non-electrical machinery industry. Also while general purpose machinery(356), agricultural machinery (350) and special purpose machinery (359) show increased shares; food and textile machinery(353), machine tools(357), construction and mining equipment(351) as well as prime movers(352) show a relative decline in their shares in output. The share of refrigerators, airconditioners etc(355) doubled between 1981 and 1998 and while the share of office computing machinery(358) is small its share also doubled in the post-reform period.

Growth Performance: The performance of the non-electrical machinery industry is closely related to the growth performance of the economy. Given the inward focus of this industry, the growth of this industry is dependent on domestic investment, especially by the government. In the second and third five year plans, high growth rates of over 15 per cent were achieved by several industries like machine tools, textile machinery, chemical machinery etc. In the period 1955-56 to 1964-65, non-electrical machinery industry recorded a phenomenal growth of 22.5 per cent. The industry was however severely affected by the recession and grew at a rate of less than 5 per cent during 1964-65 to 1975-76. Between 1975-76 to 1984-85, this industry grew at 5.8 per cent(Bhagavan, 1985; Mundle & Mukhopadhyay,1992).

In assessing the growth performance of the industry, we find from the data based on Index of Industrial Production[6] that the growth performance of machinery, machine tools and parts in comparison to overall manufacturing or even capital goods, is lower in all three periods (Table 2). In order to evaluate the performance of the non-electrical machinery industry, we used ASI data to estimate trend growth rates[7] for the non-electrical machinery industry for the ten component industries at the three-digit level. Table 3 gives the output growth performance for these industries for the period 1980-81 to 1997-98[8]. We find that the growth rates in the post reform period (second period i.e 1991-92 to 1997-98) are higher for non-electrical machinery as well as for eight of the ten three digit industries. Only construction and mining equipment(352) and other industrial machinery(354) registered lower growth rates. Thus the post reform growth performance of non-electrical machinery as well as most of its

Table 1: Share in Non-Electrical Machinery of Component Industries (%)

NIC code/Industry		No. of employees			Value of output(1993-94 prices)		
		1980-81	1990-91	1997-98	1980-81	1990-91	1997-98
350	Agricultural machinery	9.67	9.24	10.54	13.15	15.03	16.48
351	Construction & mining Equipment	5.59	6.84	3.75	7.00	5.74	4.02
352	Prime movers, boilers, steam turbines	14.68	13.32	13.46	19.51	16.96	14.00
353	Food & textileMachinery	18.33	13.42	12.48	14.35	13.16	12.93
354	Other Industrial Machinery	9.94	12.02	11.07	8.68	10.82	7.41
355	Refrigerators, airconditioners etc.	5.33	8.40	6.93	5.33	8.37	10.09
356	General purpose Machinery	14.76	17.68	22.14	18.17	18.37	20.32
357	Machine tools, parts & accessories	12.51	10.17	9.76	9.08	6.51	5.60
358	Office computing machinery	1.87	1.01	0.81	0.85	0.80	1.67
359	Special purpose machinery	7.32	7.91	9.05	3.87	4.24	7.48
35	Non-electrical Machinery	100.00	100.00	100.00	100.00	100.00	100.00

Source: Estimated from ASI data.

Table 2: Rates of Growth of Machinery, Capital Goods and Manufacturing

Industry	1980-81 to 1990-91	1991-92 to 1997-98	1980-81 to 1997-98
Machinery, machine tools and parts	5.97	6.74	5.53
Capital Goods	11.34	8.43	8.99
Manufacturing	7.74	8.18	7.05

Source: Calculated from data on Index of Industrial Production.

component industries was better than the pre reform performance. In the case of agricultural machinery(350), refrigerators and airconditioners(355), office computing machinery(358) and special purpose machinery(359), the post reform growth rates are much higher. Machine tools (357) also recorded an impressive improved performance while growth rate itself was not very high at 9.2 per cent compared to the above mentioned four industries.

In order to see whether the improved performance was significant, a dummy variable test[9] for significance of a change in the trend growth rate shows that the improved growth rates in non-electrical machinery(35) as well as agricultural machinery(350), machine tools(357), office computing machinery(358) and special purpose machinery(359) was significant. In the case of important component industries like prime movers and boilers(352), food and textile machinery(353) and special purpose machinery(356) which account for nearly half of output, the higher growth rates are not significant. A disaggregated analysis of growth performance in non-electrical machinery is thus useful as it shows the considerable diversity in performance. While except for machine tool industry(357) which showed a very low growth rate of only 2.27 per cent[10] in the first period, the overall growth rate of 6.5 per cent for the first period was achieved with more or less uniform performance of all three digit industries with very little variation. On the other hand, the period after reforms shows that the higher growth rate of 9.38 per cent[11] for non-electrical machinery was achieved with considerable variation in the performance of the component industries. While in the pre reform period, all industries enjoyed a protected market, the wide ranging reforms since 1991 seem to have affected the component industries of non-electrical machinery differently as is seen in the disaggregated growth analysis.

Thus a review of the performance of the non-electrical machinery sector

Table 3: Rates of Growth of Output in Non-electrical Machinery Industry

NIC code/ Industry	1980-81 to 1990-91	1991-92 to 1997-98	1980-81 to 1997-98	Dummy variable Sign	significance
350 Agricultural machinery	7.56	13.13	8.63	+	significant
351 Construction & mining equipment	6.70	4.10	7.02	–	not significant
352 Prime movers, boilers, steam turbines	6.00	7.77	4.38	+	not significant
353 Food & textile machinery	6.54	8.98	7.55	+	not significant
354 other Industrial machinery	8.51	6.25	7.3	–	not significant
355 Refrigerators, airconditioners	9.06	17.14	11.55	+	not significant
356 General purpose machinery	6.57	9.6	7.15	+	not significant
357 Machine tools	2.27	9.2	3.1	+	significant
358 Office computing machinery	9.4	21.89	9.55	+	significant
359 Special purpose machinery	8.73	19.08	12.3	+	significant
35 Non-electrical machinery	6.5	9.38	6.61	+	significant

Source: Estimated from ASI data.

shows that on an aggregate, the performance of this industry has not been drastically affected by liberalisation measures in the decade of the 1990s. Thus, ironically, with wide ranging trade reforms including tariff reforms and reduction in duties on capital goods imports, the domestic machinery industry was faced with competition but performed reasonably well. Given the inward focus of the non-electrical machinery industry in India, which is primarily oriented to the domestic market, the explanation for the improved growth performance lies in the high overall growth of the economy and increased investments during the period until mid-1990s. Since 1996 however, except for 1999-2000, the performance has been poor. This again is attributed to decline in investment and general downturn in the economy. Since this industry is dependent on investment driven demand, a squeeze in investment particularly public investment had its impact on this industry. (Uchikawa, 2001,2002; Kumar, 2000). However, within the sector we find that reforms have affected the component industries differently with only four of the industries showing a significantly improved performance. Some of the industries like textile machinery and machine tools have been greatly affected by imports with the share of imports in domestic availability increasing(Appendix-Table 3). Given the importance of the textile industry in the national economy, the textile machinery sectors performance has been poor with imports far exceeding domestic production in a number of segments like weaving, processing, knitting, etc.(Roy,2004). Likewise, given that user industries of machine tools include the entire manufacturing sector, liberal imports and increased competition have affected the growth performance. In both the industries, a major technology gap emerged by mid-1970s between domestic and global machinery manufacturers (Khanna,1992;Tulpule and Datta,1990)) with the result that progressive liberalisation in capital goods imports affected both the textile and machine tool industry adversely. Again the growth performance of important components industries like prime movers and boilers and general purpose machinery has also been poor. We now analyse the trends in imports and exports within non-electrical machinery and consider the impact of reforms on the magnitude and composition of exports and imports.

Exports and Imports of Non-Electrical Machinery: The contribution of the non-electrical machinery sector to exports has not been significant in India. An important feature of the growth of the non-electrical machinery industry in the import-substituting strategy of industrialization is that the industry had an inward focus sustained by a large domestic demand fuelled by the investment

expansion of the government. Exports of non-electrical machinery as per cent of total exports increased from 0.47 per cent in 1960-61 to 1.85 per cent in 1970-71 and further to 3.2 per cent in 1980-81. This figure has remained more or less the same since then with the share being 3.41 per cent in 1999-00. Imports of non-electrical machinery are higher and as per cent of total imports were 18.13 per cent in 1960-61, 15.77 per cent in 1970-71 and peaked to 21.68 per cent in 1986-87. In 1995-96, this figure was 11.71 per cent and declined to 6.05 per cent in 1999-00[12].

In order to analyze imports and exports of items of machinery corresponding to non-electrical machinery, we look at the detailed four digit ITC classification for categories 8401 to 8485. After dropping 8471 and 8473[13], average shares for all the 83 categories as per cent of the total for all 83 industries are obtained for two periods-1991-96 and 1997-03. Those industries with an average share of 2 per cent or more are identified for the two periods and grouped into three categories given in Tables 4&5 While the discussion below is in terms of average shares, in terms of magnitude, imports of non-electrical machinery are much larger than exports. Between 1991 and 2003, imports increased from 1893.58 m$ to 3663.26 m$ while exports increased from 379.38 m$ to 1463.65 m$. On an average, the value of imports is 4.61 times that of exports for the period 1991-96 and 3.2 times that of exports for the second sub period.

Of the 83 four digit industries, from Table 4 we observe that the average share of just 17 industries (whose average share is greater than 2 per cent) in imports is 65 per cent for the period 1991-96 and 61 per cent in 1997-03. Those with average share more than 5 per cent were four in number during 1991-96, but only one of these four industries has an average share of more than 5 per cent during 1997-03.

The slow down in industrial sector performance led to a general decline in imports of machinery after 1996. Thus with a decline in industrial performance, not only did imports decline in absolute terms (Figure 1), the share of certain categories of machinery which traditionally account for bulk of imports declined so that imports of machinery within the non-electrical machinery sector became more broad based.

From Table 5, we find that over 60 per cent of exports of non-electrical machinery are on an average accounted for by only 12 to 15 of the 83 four digit industries. The bulk of exports is thus concentrated in a narrow range of industries.

Table 4: Average Share of Important Four Digit Industries in Imports of Non-electrical Machinery

Average Share	1991-96 No. of Industries	Code	Share(%)	1997-03 No. of Industries	Code	Share(%)
Group A: > 5%	4	8431	6.67	1	8479	5.77
		8445	6.63			
		8479	6.04			
		8483	6.04			
Group B: 3-5%	7	8409	3.34	8	8409	4.10
		8411	3.99		8413	3.70
		8413	3.02		8414	3.94
		8414	3.22		431	3.47
		8448	3.93		8445	3.45
		8481	3.51		8481	4.23
		8482	4.36		8482	4.13
					8483	4.69
Group C: 2-3%	6	8419	2.16	10	8411	2.53
		8443	2.30		8421	2.22
		8446	2.28		8447	2.17
		8452	2.00		8448	2.24
		8466	2.39		8455	2.42
		8477	2.78		8474	2.01
		8419	2.60		8443	2.45
					8477	2.79
					8480	2.46
Total(>2%)	17	64.6	6	19		61.37

Source: Based on data from India Trades[14], CMIE.

Further, we note that of these 12 industries, 6 industries for the period 1991-96 and 5 industries for the period 1997-03 which had an average share of more than 5 per cent accounted for 43 per cent and 34 per cent respectively of exports of machinery from India. Thus, we find that in both imports and exports certain specific categories of non-electrical machinery dominate. Empirical evidence on intra-industry trade(Viramani,1999) indicate the exchange of commodities differentiated by quality in the capital goods sector with India exporting cheap varieties of capital goods and importing the more expensive varieties.

Figure1 gives the trends in imports and exports for the period 1991-03 and Table 6 gives the growth rates for the different sub periods. It is clear that imports as well as exports grew rapidly during the period 1991-96, with import growth rate being higher than export growth rate. During, 1997-03, however, both growth rates declined, with the growth rate for imports turning negative. Thus it is clear that not only the growth performance of the domestic non-electrical machinery sector, but also the import and export performance of the sector is related to the overall performance of the manufacturing sector.

Figure 1: Imports and Exports of Non-electrical machinery, 1991-03

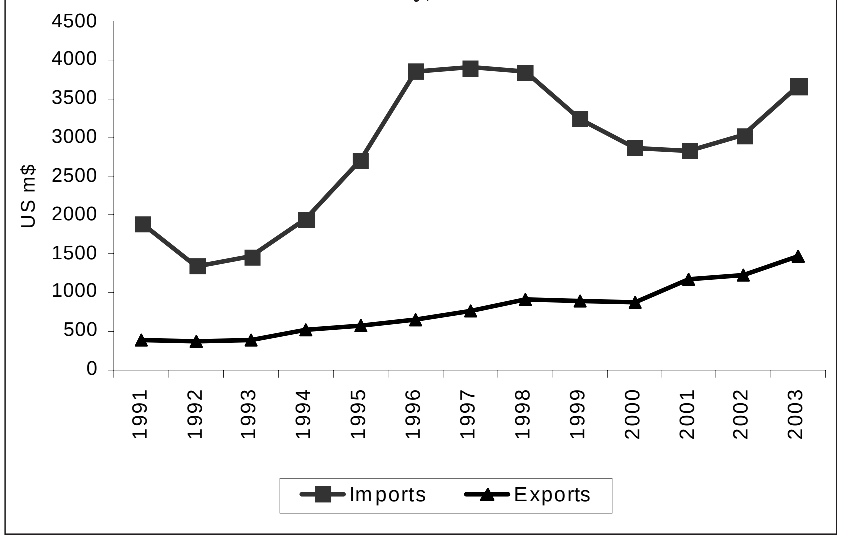


Table 5: Average Share of Important Four Digit Industries in Exports of Non-electrical Machinery

Average Share	1991-96			1997-03		
	No. of Industries	Code	Share(%)	No. of Industries	Code	Share(%)
> 5%	6	8408	7.56	5	8408	5.13
		8409	11.80		8409	9.33
		8413	6.01		8413	6.58
		8414	6.02		8479	7.30
		8445	5.43		8481	5.58
		8479	6.55			
3-5%	2	8448	4.86	5	8414	4.87
		8481	3.21		8448	4.09
					8466	3.64
					8477	3.47
					8482	4.01
2-3%	4	8407	2.29	5	8419	2.43
		8419	2.10		8421	2.09
		8466	2.99		8443	2.23
		8477	2.49		8444	2.05
					8483	2.20
Total(>2%)	12	61.31		15		65.01

Source: Based on data from India Trades, CMIE.

Table 6: Rates of Growth of Imports and Exports of Non-electrical Machinery in the Post Reform Period

Period	1991-96	1997-03	1991-03
Imports	18.5	-2.83	6.92
Exports	12.81	10.71	12.43

Source: Estimated from Data from India Trades, CMIE.

In Table 7, in order to identify and establish correspondence with the ASI classification, we regrouped the 19 industries in imports and 15 industries in exports of Tables 4&5 according to the three digit ASI classification. From the table we see that categories of exports and imports which are important and which have an average share of 2 per cent or more do not include the ASI three digit industries namely-agricultural machinery(350), refrigerators and airconditioners(355) and office accounting machinery(358). Food and textile machinery(353), other industrial machinery(354) and general purpose machinery(356) together account for nearly half of imports of non-electrical machinery. These are the industries which did not show significantly improved growth performance in the post reform period. In exports, prime movers, boilers(352) together with other industrial machinery(354) and general purpose machinery(356) account for over 50 per cent of total exports for the period 1997-03.

While Table 7 grouped only the four digit industries with average share of 2 per cent or more, an examination of all the important 83 four digit categories

Table 7: Average Shares of Industries (with share >2%) in Imports and Exports by ASI Classification

ASI Code and Industry	Imports		Exports	
	1991-96	1997-03	1991-96	1997-03
351 Construction and mining Equipment	6.67	3.47	-	-
352 Prime movers, boilers, turbines	7.33	6.63	21.65	14.46
353 Food & textile machinery	12.84	7.86	10.29	6.14
354 other Industrial machinery	15.28	20.50	11.14	15.43
356 General purpose machinery	20.15	20.69	15.24	23.25
357 Machine tools	2.39	-	2.99	3.64
359 Special purpose machinery	-	2.22	-	2.09
Total	64.66	61.37	61.31	65.01

Source: Based on data from India Trades, CMIE.

and their classification corresponding to the three digit ASI classification is given in Table 8. Over 80 per cent of imports and exports of non-electrical machinery correspond to just five ASI industries. The share of the remaining five industries(350,351,355,358,359) in trade is thus not significant. Thus we find that other industrial machinery(354) and general purpose machinery(356) account for bulk of imports(nearly 45 per centto 50 per cent) of non-electrical machinery in India. In exports, besides these two industries, prime movers, boilers and steam turbines (352) also have a high share. From Table 8 we find that in three of the ASI three digit industries, imports declined and there is a sharp decline in imports of textile machinery after 1996. Again from Table 8, we see that three of the component industries of non-electrical machinery-prime movers etc(352), other industrial machinery(354) and general purpose machinery(356) account for nearly 68 per cent of total exports of non-electrical machinery.

Thus, our review of the non-electrical machinery sector so far has established the inward orientation of this industry. Production has been mainly aimed at the large domestic market while exports of machinery and equipment have not been significant. It has been argued that in the period after mid-60s when many domestic machinery sectors had excess capacity following a recession, firms could have produced for export markets but did not do so since they lacked the competitive edge. The pursuit of import substituting industrialisation strategy and the protection offered to domestic industry is often regarded as the main cause for lack of efficiency in this sector. An alternative scenario is one where the ISI and protection measures enabled the sector to accumulate physical capital, technology and experience which over time led to the emergence of a competitive capital goods sector. This happened for

Table 8: Average Share of Important Industries in ITC 84 Grouped by ASI Classification

	Imports		Exports	
ASI Code and Industry	**1991-96**	**1997-03**	**1991-96**	**1997-03**
352 Prime movers, boilers, turbines	12.64	11.77	26.09	20.22
353 Food & textile machinery	15.15	10.44	14.09	9.53
354 other Industrial machinery	22.29	24.20	17.41	21.65
356 General purpose machinery	22.82	24.93	21.19	25.96
357 Machine tools	10.07	9.54	9.38	8.21
Total	82.97	80.88	88.16	85.57

Source: Based on data from India Trades, CMIE.

example in the case of the Brazilian economy(Teubal,1984) where the capabilities accumulated during ISI and infant industry stages led to an acceleration in exports after 1973 when underutilization of domestic capacity emerged as a result of government cut back in expansion plans for basic industries. The result was that a dual relationship emerged between local and export markets. In the short run the two were substitutes so that a reduction in domestic demand would tend to increase exports for given capacity and output and in the long run they are complimentary so that stimulation of local demand will, by making it possible to increase efficiency eventually increase exports. In the case of the machinery sector in India, there is no evidence of a gradual building of capabilities eventually leading to outward orientation. It is in this context that we now briefly examine the question of efficiency in the industry before looking at the development of technological capabilities in the non-electrical machinery sector.

Efficiency of the Non-electrical Machinery Industry: A number of studies have examined the question of efficiency and capacity utilisation in the capital goods sector including the non-electrical machinery industry. The studies on industrial sector deceleration generally argued that in the pre-liberalisation period, lack of competition contributed to inefficiency and gross underutilization of capacity in the industrial sector. An alternative view regarding the link between inefficiency and controls is that it is the nature of controls rather than the presence or lack of it that go towards rendering manufacturing expensive relative to international markets (Chandrasekhar,1992). It is argued that the imposition of a number of duties on basic raw materials and components led to distortions contributing to lack of price competitiveness in machinery manufacturing. A World Bank(1982) study on the non-electrical machinery industry in India found that the leading manufacturers were technologically competent, financially viable and capable of supplying complete economic sized units to user industries. The study noted that the industry was capable of supplying complete, economic sized units to the cement, sugar and thermal power industries. It was also able to meet about 80 per cent of the machinery requirements for large sized paper and pulp plants and 50 to 60 per cent of the machinery to the chemical industry. The Indian machinery manufacturing plants were also rated favourably compared to their Western counterparts in the use of labour and other inputs. The team was impressed with the 'high' quality and professional capability in management in all units whether in the public or private sector. The team noted that the leading manufacturers produced

equipment and machinery of competitive international quality and which were up to the standard of world equipment producers in manufacturing capacities and in efficiency of raw material use. Several leading plants had been pre-qualified by international consulting engineers and contractors for the manufacture of mechanical equipment and participation in international competitive bidding.

The World Bank team also calculated the effective protection coefficient and domestic resource costs of local production and found that India emerged as an efficient producer in all but three of the 19 categories of equipment studied. Despite higher domestic costs of inputs, the output prices for many items were found to be significantly lower in India than abroad. The report, concluded that the situation would have been better had there not been net disincentives to the sector because of greater protection on inputs than on outputs.

An empirical study by Parameswaran(2004) using panel data for the period 1988-89 to 1997-98, examines the impact of liberalisation measures in the capital goods sector on technical change and efficiency change. The study finds a declining level of technical efficiency in all four capital goods industries including non-electrical machinery. Also, the rate of decline in technical efficiency is faster after 1991-92 in this industry. The study also finds that the capital goods industries experienced technological progress with the rate of progress being higher after 1991-92; the result being that the distance between the actual and frontier output widened.

Similar to the explanations advanced for inefficiency arising from policy aspects is the view that the persistence of excess capacity in the manufacturing sector is also a natural outcome under certain trade regimes irrespective of demand conditions or the reversibility of capital decisions. Capacity underutilization is a natural outcome when quotas are based on installed capacity with firms often investing in additional capacity not to produce output but because it provides a basis for obtaining a more generous allocation of imported inputs(Sahay,1990). While traditional measures of capacity utilisation based on installed capacity and actual output reveal low utilisation rates for non-electrical machinery, econometric measures obtained in a cost minimisation framework were closer to unity suggesting that actual output levels are determined by cost considerations (Padma Suresh, 1991).

5. Technological Developments and Role of FDI in the Non-electrical Machinery Industry

The ability of a country to export capital goods including machinery would indicate a high level of technological sophistication in the economy. The acquisition of technological capability in developing countries has been the focus of a number of studies These studies indicated that an increase in hardware capacity must go together with development of local skills and knowledge to effectively assimilate technology, adapt it to local conditions, improve upon it and ultimately create new technology locally (Lall,1986;Romijin,1997).

The non-electrical machinery industry produces medium to high technology products that are the core of industrial activity. The products are non-homogenous and technological capabilities are needed to meet world standards. To establish export capability in engineering products especially machinery manufactures, the emphasis of R & D needs to be on product design and development or innovation. A basic distinction that is emphasised in the case of machinery manufacturing is between learning to manufacture or the acquisition of manufacturing (i.e. productionising) capabilities and the acquisition of design capability (Teubal,1984). The former refers to the gradual mastery of an increasing range of manufacturing processes such as machining, welding, assembly etc. The ability to productionise is well documented in the Indian context. To quote Pillai(1979),"For products, we have the ability to productionise, given drawings". But technological capability involves more than productionising ability. In machinery manufacturing, it is the acquisition of design capability that is crucial for innovation. For it is this ability which enables the firm to specify the equipment (product) required for a particular manufacturing process (user). This requires a deep knowledge of materials and an understanding of the specificity of user industry's requirements. Again, in design capabilities, it is important to distinguish detail design capability from basic design capability. While detail design capability enables a product to be adapted to a particular application and availability of raw materials, components etc without modifying the general type or class; basic design capability on the other hand may enable a firm to adapt existing product types or to launch completely new products (innovation). It is R &D activities of firms that lead to basic design capability that enable product or process innovation and which is crucial for export competitiveness. While basic design capability is associated with innovation, the gradual mastery of production capabilities through learning by doing is also important as it results in increasing efficiency in the industrial sector.

In the first place with respect to technology it is argued that the incentive for technological innovation and upgradation was absent in India given that the domestic market was protected and there was lack of competition. Also, a firm's decision to 'make' or 'buy' technology abroad is based on cost-effectiveness of local generation. The cost of imported technology is likely to be lower than the cost of local development as the transfer of already developed technology does not entail many costs, while fresh generation in developing countries entails greater costs. However in the long run, the real costs of the failure to develop innovative activities locally are higher and it is the existence of such externalities in the technology market that calls for state intervention(Chamarik and Goonatilake, 1994).

For most machinery and equipment manufacturing firms in India, both in the public sector as well as in the private sector, the import of technology has been through a series of foreign technology agreements. In the study on technology management of HMT, S.Mani points to four broad strategies for acquiring foreign technology. They are: (1) broad based turnkey contracts for the initial establishment of the unit, as in the case of HMT(with Oerlikon for machine tools and Citizen for watches) (2) acquiring technology through bulk purchase of machinery like machines, SKD/CKD's, components and along with it the right to manufacture these machines (3) joint development and co-operation by engineers and technical personnel from India and the collaborator for design of sophisticated machines for the domestic market and (4) purchase of technology through formal technical collaboration agreements. Licensing agreements were the most predominant mode of technology import not only in machine tools but also in the machinery sector in general[15]. Most such technology agreements in the industrial sector were for an average period of five years or so by the end of which domestic firms were successfully able to absorb the imported technology.

Two points have been emphasised with respect to such import of technology. In the first place, for the most part, Indian engineering firms that imported technology from abroad made only minor adaptations leaving the core technology untouched. This was unlike countries like Japan where the initial imported technology was backed by considerable R&D effort to assimilate and subsequently develop new technologies. In the machinery sector, innovation is often 'informal' and embodied in incremental improvements in design and as such neither recorded nor often perceived as the result of an 'investment' in R&D(Basant,1997). Thus, in India, not only was R&D effort small; a predominant

part of R&D was devoted to shop-floor based problem solving related to running, maintaining, repairing and making minor changes to technology in response to local conditions. A number of case studies of modification of imported technology have documented the minor adaptations made to technology in the Indian context (for e.g see Ito,1986).

In the second place, besides the direct costs in terms of licence fees and royalties, indirect costs of such technology imports were significant in terms of restrictive clauses relating to exports, tied purchase of machinery and components, etc.

The inability to master industrial technologies has been associated with many inherent structural weaknesses in the development of indigenous technology(Patel,1989). In the development of indigenous technology, the role of an appropriate technology policy environment and incentives for encouraging R&D is significant. There has been a significant expansion in such research infrastructure as well as a rapid growth of scientific education and skilled manpower base.(Mani,2003). There are about 1300 in-house R&D centres in the industrial sector. In addition industrial research is undertaken through a network of laboratories and field stations set up by the Council for Scientific and Industrial Research (CSIR). Identification and promotion of priority areas in R&D is done by Science and Engineering Research council (SERC) set up under the Department of Science and Technology (DST).

In the case of the non-electrical machinery sector, the main issues pertaining to technology development can be categorised as follows- (1) the development of technology in the public sector (2) the role of independent public funded research institutions(3) the development of technology in the private sector and(4) the role of fiscal incentives in enabling and promoting R&D.

(1) One of the avowed reasons for the establishment of PSEs in the heavy engineering sector like HMT, HEC, BHEL etc. was to enable India to build a strong foundation of technical know-how. Many of these PSEs have in-plant R&D units and over the years there has been an upgradation in R&D facilities in these PSEs. However, it is argued that building up technological capacity, in contrast to production capacity in the public sector was crippled from the very beginning. This was because the establishment of PSEs was through tied aid either on a turnkey basis or with import of machinery, components etc. While this involved substantial training of local manpower for taking on technical

responsibilities for operation of plants; national participation in preparing blueprints and their execution was marginal thus inhibiting the further growth of technological capabilities(Patel,1989). Also the significance of public sector R&D in industrial R&D is declining (Mani,2003;Singh, 2001).

(2) As far as government funded research institutions are concerned, in order to facilitate indigenous R&D in the non-electrical machinery industry, the government set up the Central Mechanical Engineering Research Institute (CMERI) in 1958 at Durgapur. With the adoption of the second five year plan imports of machinery and capital goods had increased and the role of the CMERI in fostering self-reliance in the Indian industry was crucial. The stated objectives of this institute included development of new products, processes, innovation; design of machinery and equipment; fabrication of pilot plants and prototypes; fabrication and standardisation of materials and finished components of machinery; training of research workers etc; maintaining collaboration with heavy, light and precision engineering industries and offering consultative aid including testing etc. Given the dispersal of industrial units all over the country and the inability of CMERI to provide immediate solution to their shop-floor problems, the Mechanical Engineering Research and Development Organisations (MERADOs) were set up in Pune, Ludhiana, and Madras in 1965-66 and in Cochin in 1976.

The CMERI and MERADOs were established with the objectives of development and diffusion of new technologies. However it is argued that the link between domestic industries and research institutions was not very strong. CMERIs link with PSEs in the mechanical engineering field like HMT, HEC etc in co-ordinating R&D with these organisations was not significant (Bhattacharya, 1988).

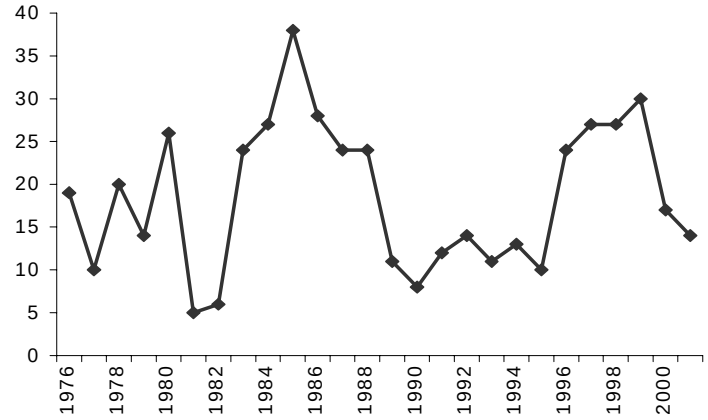
Aiding the R&D capabilities in the non-electrical machinery industry, are a number of other research organisations under the government like CMTI, Tool Room and Testing Centres, Testing Laboratories, Prototype Development Centres etc. which have contributed to development of designs and prototypes and facilitated transfer of technology. The CMTI in particular has played an important role in technology development and diffusion in the machine tool industry. But again evidence from the case study on machine tool industry shows the lack of proper utilisation of such existing technological infrastructure. The role of such supporting institutions in the liberalised era needs to be reassessed to ensure full utilisation of their capacity.

(3) The growth of the private sector in India has been through reliance on external technology. At the firm level it is only larger enterprises in the private sector with a command of substantial resources that can afford in-house R&D units. Collaborative effort by industry associations like machine tools and textiles has also resulted in the setting up of industry level R&D/training facilities. Given the increasing privatisation of R&D expenditure, with 70 per cent of it accounted for by the private sector(Mani,2003), the nature of such enterprise R&D efforts in the private sector is important. However we find that in the first place, the magnitude of such R&D expenditure is small both in absolute terms as well as in terms of R&D expenditure as per cent of sales. Secondly, the nature of R&D activities in most cases is for modifications to imported technology involving design changes for cost reductions in the face of competitive pressures, or to suit locally available raw materials, components and parts, local climatic conditions etc. (Ito, 1986). The kind of basic research needed to be in the frontier of technological knowledge is beyond the scope of enterprises in the private sector in India.

(4) There are a number of fiscal incentives to encourage technology development in industry. Two main categories of fiscal incentives are research schemes and tax incentives. The research schemes available to industrial enterprises are essentially loan schemes with a concessional element like TDB of DST, Home Grown Technology Programme(HGT) of TIFAC, Technology entrepreneurs Promotion Programme(TePP) of DSIR&DST etc. The only research grant scheme is PATSER (Programme Aimed at Technological Self Reliance)which is administered by DSIR and which have been availed mostly by PSEs. The conclusion which emerges from a review of such research schemes by Mani(2003) is that overall the extent of subsidies for research in the enterprise sector is very low. In addition tax incentives both direct and indirect show considerable year to year changes and available data review shows that most of the schemes are not very popular. Fiscal incentives therefore have not been significant in inducing firms to undertake innovation measures as is also evident from response of firms in the machine tool industry(Section 6).

Liberalisation and Foreign Collaborations in Non-electrical Machinery: It is expected that the post reform period would witness increased recourse to foreign collaborations given increased competitive pressures. Data on foreign collaboration approvals reveals that, of the total approvals, the share of the

Figure 2: Foreign Collaborations Approvals in Machine Tools 1976-2001

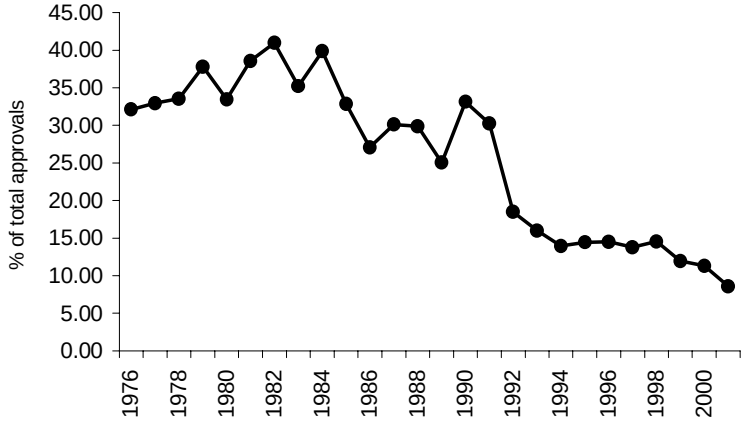


non-electrical machinery sector in technical collaborations is higher than its share in financial collaborations. Also, from the data on trends in foreign collaboration approvals in the non-electrical machinery industry given in Appendix-Table 4, we note two points. The first is that there is an increase in approvals in mid-1980s in machine tools as well as industrial machinery while mechanical engineering approvals increased in mid-1990s. The impact of liberalisation from the mid-80s saw a rise in approvals in the case of machine tools (Figure 2) clearly indicating an increasing number of firms in the industry seeking collaborations for manufacture of CNC machine tools as discussed in the case study on machine tools.

The second and more pertinent point to note is that, on the whole the non-electrical machinery sector's share in total approvals has declined significantly from 32 per cent in 1976 to barely 9 per cent by 2001 while the share of other sectors like electrical and electronics, chemical etc. increased(Figure 3).

Thus vis-à-vis other sectors we find that the machinery sector is lagging behind in terms of access to new technologies given the sectors declining share in foreign collaborations. Given the absence of national development of technologies in this sector and the dependence on imported technology this trend may have adverse implications for future growth performance and competitiveness of this sector.

Figure 3: Foreign Collaborations Approvals in Non-electrical Machinery as per cent of Total Approvals: 1976-2001



The final issue that we consider here briefly is the role of FDI in strengthening international competitiveness and promoting outward orientation. Key FDI benefits are productivity growth due to increased access to technology through joint ventures and licensing, enhanced knowledge of international market conditions and access to foreign marketing networks (Kumar and Pradhan, 2003a). Thus while the role of FDI in providing impetus to domestic economy and export competitiveness is well recognised, we note from the data on foreign collaborations that the role of FDI in non-electrical machinery sector in India is not significant.

Since the liberalisation measures adopted in India, FDI inflows have increased but bulk of these investments have been in infrastructure and services like power, telecommunications etc. as is clear from Table 9. Within the capital goods sector, the share of electrical and electronic equipment (9.83 per cent of total FDI) is higher, while transport industry (7.38 per cent) also has a higher share in FDI inflows than non-electrical machinery whose share is only 2.02 per cent.

6. Machine Tool Industry- A Case Study

The machine tool industry[16] being a 'mother machinery' industry is a small but important sector of Indian manufacturing. Since the user industries of machine tools include the entire manufacturing sector the performance of this sector has

Table 9: Share of Different Industries in FDI Approved between 1991-2002

Industry	No. of approvals Total	Technical	Financial	Amt. of FDI approved (In rupees)	(In US $)	% of total FDI approved
Fuels	928	276	652	774719.62	20921.35	27.21
Telecommunications	858	127	731	562786.93	15198.12	19.77
Electrical and electronic equipment	5033	1180	3853	279776.57	7052.93	9.83
Transport industry	1562	612	950	210122.25	5518.44	7.38
Non-electrical Machinery of which	2929	1479	1450	57416.89	1601.47	2.02
Boilers and steam generating plants	83	46	37	1471.58	44.28	0.05
Prime movers	61	38	23	917.24	6.04	0.03
Industrial machinery	1464	835	629	26064.15	756.51	0.92
Machine tools	217	89	128	4004.97	110.28	0.14
Agricultural machinery	50	32	18	4577.85	128.37	0.16
Earth moving machinery	73	45	28	2430.96	59.33	0.09
Misc. Mech. & Engg.	981	394	587	17950.14	476.66	0.63

Source: SIA Newsletter, Annual Issue,2002.

implications for technology development and productivity of the overall manufacturing sector. This section includes a review of the machine tool industry and results based on responses obtained from a primary survey of some leading machine tool firms in the organised sector on competitiveness issues.

Technological Developments and the Global Scenario: Technological developments in the machine tool industry had a major role to play in the evolution and growth of the industry in different countries. Beginning in the early 1970s a major technological development in machine tools was that of equipping machines with computer control systems. This revolutionary change in the machine tool industry led to a new class of machine tools, which greatly enhanced productivity and quality. Since then increasingly, production of machine tools has shifted from conventional to numeric control (NC) and computer numeric control (CNC) machine tools.

At the beginning of the 1980s, the US -where the new technology of CNC had originated- was the world's largest producer of machine tools. But by mid-1980, Japan emerged as the world's leading producer of machine tools. By 1986, Fanuc of Japan produced 50 per cent of the world's total production of CNC control systems. The implication of such large volumes was huge profit margins for the company, enabling it to further invest significantly in R&D.

These technological developments had important implications- firstly, the emergence and rapid spread of CNC machine tools in user industries lead to a decline in the demand for conventional machine tools. The failure to recognise the market trends led to a decline in the fortunes of many established machine tool firms world-wide including India (for example Mysore Kirloskar). Secondly, there was a major change in the proportion of costs incurred in the manufacture of machine tools. Unlike in conventional machine tools, in CNC machine tools, the major cost component comprises the core parts comprising the CNC system itself as well as other high technology components like ball screws etc. The manufacture of these components is dominated by a handful of manufacturers worldwide- CNC systems production is dominated by Fanuc(Japan) and Siemens(Germany), while the manufacture of ball screws is also dominated by a handful of specialist producers. Thus, typically today around 40 per cent or more of the value of a CNC machine tool comprises these core high technology components which need to be imported outside of the manufacturing countries.

The global machine tool industry witnessed wide fluctuations during the 1990s and a sharp decline in the early 1990s. Japan and Germany are the top producing nations and account for 42 per cent of the output while United States is the fifth largest producer, behind China[17]. Currently, Japanese (e.g.Mazak, Okuma, Mori Seiki etc) and German (e.g.Thyssen, Trumpf, Gildemeister) machine tool firms dominate the list of largest machine tool manufacturers in the world. In the last decade, USA and Asia have emerged as the major machine tool demand regions in the world. China is the world's fourth largest producer of machine tools but the rapidly growing Chinese economy has made it the largest consumer of machine tools. China is also the largest importer of machine tools and the country having the most unfavorable machine tool balance. Amongst the top exporting countries are Germany, Japan, Italy, Taiwan and Switzerland. Both Taiwan and Switzerland exported more than 80 per cent of their production in 2003 while the corresponding figure for India is only 9 per cent. Imports, as a per cent of consumption was 61 per cent for China, 66 per cent for US and 50 per cent for India.

Evolution and Structure of the Machine Tool Industry: The machine tool industry in India has a long history that can be traced to 1890s. In 1937, Cooper Engineering Ltd. was set up and Kirloskar Brothers began production of centre lathes in 1941. During the Second World War the industry expanded capacity to meet defence requirements (Matthews,1988). In post independent India, the evolution and growth of the machine tool industry has been influenced by state policy. The establishment of HMT and its subsequent expansion and diversification was consistent with the prevailing ideology of predominant state control in this sector. HMT was set up in 1953 and commenced production in 1956. HEC was set up in 1966 to produce medium and heavier range special purpose machine tools for government projects like mining and steel plants as well as railways and defence sectors. Praga Tools was set up in 1943 with Czech collaboration and taken over by the government in 1958. The company was with the Ministry of Defence during 1963-86 and since 1986, the company has become a subsidiary of HMT Ltd. The private sector supplemented the output of the public sector and in the 1960s a number of machine tool companies were set up in the private sector including Sandvik Asia Ltd.(1960) and Widia (India) Ltd. (1964), Bharat Fritz Werner(1961), The Premier Automobiles Ltd.(1961) and PMT Machine Tool Automats Ltd.(1964). The late 1970s and 1980s saw a number of technocrat entrepreneurs setting up medium and small firms like Ace Designers(1979), Lakshmi Machine Works(1988) and Lokesh Machines(1983).

The machine tool industry comprises over 150 manufacturers in the organised sector and over 300 small units in the unorganised sector. Some of the largest machine tool manufacturers are based in Bangalore and Pune. Many of the smaller units are engaged in producing parts and accessories of the machine tool industry and are located in industrial clusters around Coimbatore in Tamil Nadu; Batala and Ludhiana in Punjab, and Rajkot and Surendranagar in Gujarat. In terms of the value of output the market is concentrated with about twenty of the largest units in the organised sector accounting for nearly 80 per cent of total production. HMT continues to be the single largest producer accounting for over 30 per cent of the total production. Table 10 gives the sales figures of some major machine tool companies in the organised sector.

Through the 1950s and 1960s, Indian machine tool industry gained the capability to produce a range of general purpose machines like center lathes, radial drilling machines, milling machines etc. By the 1970s the range of domestically produced machine tools extended to precision tools like gear making machines, electro-discharge machines etc. The 1980s saw a shift in preference in the user industry demand in favour of CNC machine tools that had by then already diffused worldwide. But the technological capability for

Table 10: Sales of Some Major Companies

(Rs. million)

Company	Year of Commencement	Sales 1990-91	1994-95	2000
HMT Ltd.	1953	2365.7	2304.5	3000
Widia(India) Ltd.	1964	477.4	735.5	2210
Mysore Kirloskar	1941	348.1	569.7	1200
Sandvik Asia Ltd.	1960	145.6	185.4	811
Ace Designers	1979	-	-	471.9
Bharat Fritz Werner Ltd.	1961	-	-	462.5
The Premier Automobiles Ltd.	1961	333.6	135.3	430.48
Lakshmi Machine Works	1988	79.5	252.5	400
Praga Tools Ltd.	1943	363.6	208.8	400
PMT MT Automats Ltd.	1964	-	-	300
Batliboi & Co.	1892	517.0	606.7	275.8
Electronica MT	1979	-	-	288.54

Source: 1990-91 & 1994-95 sales figures are from CMIE, Industry, Market Size and Shares, January, 1996 while 2000 sales figures are from IMTMA.

the production of CNC machine tools had yet to be established in India with the result that imports of such machines surged. Between 1980 and 1985, more than a thousand such machines were imported. In 1985, CNC machine tools represented only 7 per cent of total domestic production. But by 2002, however the proportion of CNC machine tools in the value of total production had gone up to two thirds.

Since there is no single homogenous market for machine tools and machine tool manufacturers produce a range of machine tools we find that in specific segments of the market there is competition among a few units. For example the market leader for CNC lathes is Ace Designers, while other competitors are HMT, LMW, Galaxy, Lokesh Machines etc. For machining centres, the major producers are Ace Manufacturing Systems, BFW, HMT, LMW, Batliboi and TAL Manuf. Solutions(previously TELCO). In the manufacture of transfer machines and gear cutting and grinding machines used in the automobile industry, besides HMT, the automobile manufacturers Premier and TAL are major producers. In EDMs, Electronica Machine Tools commands a sizeable segment of the market while HMT faces little competition in the manufacture of die casting machinery used in the automobile industry and in the manufacture of precision SPMs used in avionics, satellite communication etc. In the parts and accessories segment besides a large number of small machine tool units, HMT, BFW, Birla Kennametal, Widia and Sandvik Asia are important producers.

The public sector HMT as a producer of a wide range of machine tools has played a significant role in the development of industrial capacity in the industry since independence. HMT was set up in 1953 in Bangalore with initial collaboration with Oerlikon of Switzerland. The initiation of rapid industrialisation and large investments in the second and third five year plans led to a rise in machine tool demand and consumption and the company established new units in Pinjore(1963), Kalamassery(1965), Hyderabad(1967) and Ajmer(1975). Two more units were set up in Bangalore for production of die casting machinery (1970) and precision machinery (1973). In 1970, a Central Reconditioning Unit was set up in Bangalore for reconditioning of old machinery (mostly foreign made) which need critical repair but are hindered due to either lack of machine drawings and design or technology in India. The last machine tool division to be set up was the CNC Systems Division in Bangalore in 1984 with technical collaboration from Siemens of Germany.

The company diversified into a wide range of machine tools including lathes, drilling machines, grinding machines, automats, chuckers, Special

Purpose Machines (SPMs) etc. and since the mid-1980s besides conventional machine tools a range of CNC machine tools have been produced to meet market requirements. This product diversification was facilitated through a series of over forty technical collaborations with global machine tool companies in countries like Germany and Switzerland. In most cases the company was able to fully absorb the technology by the time the collaboration agreement ended. Table 5 of the Appendix lists the major collaborations of HMT Ltd. in machine tools since its establishment.

The company performed well in the 1960s when it accounted for 55 per cent of the total value of machine tools produced. In 1966, with slowdown of growth in the industrial sector, HMT suffered losses and diversified into sectors such as watches, tractors, printing and dairy machinery etc. Liberalisation in 1990s has led to a decline in sales and the company has been making losses since 1992-93. HMT made an all time high loss of Rs.2.96billion in 1999-00 which resulted in its net worth turning negative as on 31st March 2000. Both internal and external factors have contributed to the declining performance. Among the internal factors include a large workforce and high employee costs; high overheads, and high degree of vertical integration in its plants. External factors include the move from a protected to a more liberalised regime and the higher degree of competition that followed as well as a downturn in the user industries investment and the inability to respond fast to the changing market needs from general purpose conventional to CNC machines. Although HMT had a range of CNC machines their demand did not grow to the extent envisaged due to stiff competition from both domestic producers as well as imports. With continuous losses since 1993-94, restructuring of HMT Ltd. was initiated in 2000-01 with the adoption of a Turnaround Plan involving organisational, manpower and financial restructuring. HMT Machine Tools was set up as a 100 per cent subsidiary of parent company HMT Ltd. to take over the machine tool business.

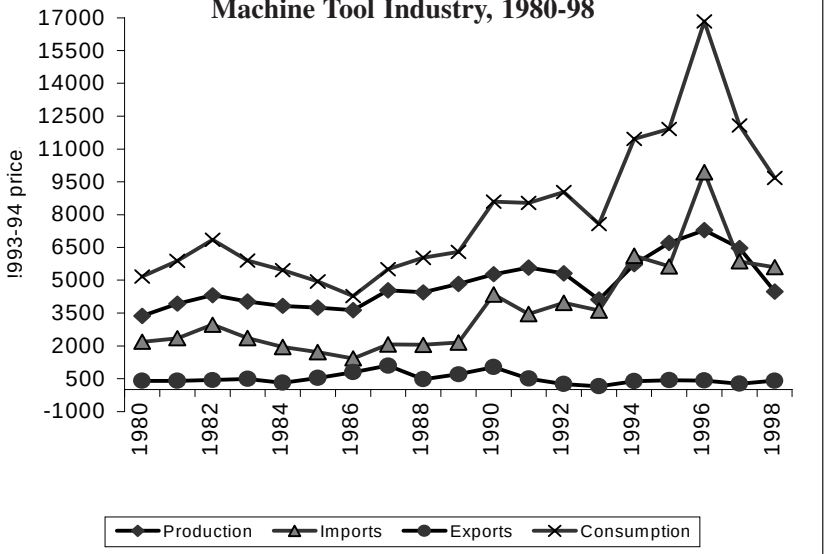
Growth Performance of the Machine Tool Industry: The protection given to machine tool industry during the three decades after independence enabled the industry to achieve rapid growth in production with machine tool industry's output growing steadily in the 1950s and until the mid-60s. Domestic production of machine tools increased from 1143 units in 1951to 15423 units in 1965. Since then the number of units of machine tools produced has declined steadily with 9284 units being produced in 1985 and in 2001, 3051 metal working machine tools were produced in the organised sector. In terms of value however,

there has been a steady increase indicating greater technological sophistication in the output of the industry. The value of machine tools output in current prices increased from Rs. 4.7 million in 1951 to Rs. 1955.8million in 1985 and further to Rs. 5268 million in 2001.

The growth performance of the machine tool industry is closely related to the performance of the user industries of machine tools. The automobile and autocomponent sector, railways, defence including ordinance factories and general engineering sector are the major user industries for machine tools. Currently, about 50 per cent of machine tools are consumed in the automobile and autocomponent sector. About 15 to 20 per cent of the industry's output represent the supplies to defence including ordinance and railways. Other engineering industries like consumer durables, farm equipment etc. account for the remaining consumption.

The slow down in the growth of the Indian economy since end of 1996 had its impact on the industry. The decline in investment by the major user industries was responsible for the lack of growth in thus industry. Since the third quarter of 2002, however, the growth performance of the Indian economy has improved

Figure 4: Production, Imports, Export and Consumption in Machine Tool Industry, 1980-98



and the automobile and the auto components sector, which is witnessing rapid growth, has been a major factor responsible for the revival of growth in the machine tool industry. On the supply side the restructuring and technological upgradation in the machine tool industry since the mid-1980s enabled the industry to meet the stringent quality requirements of the user industries.

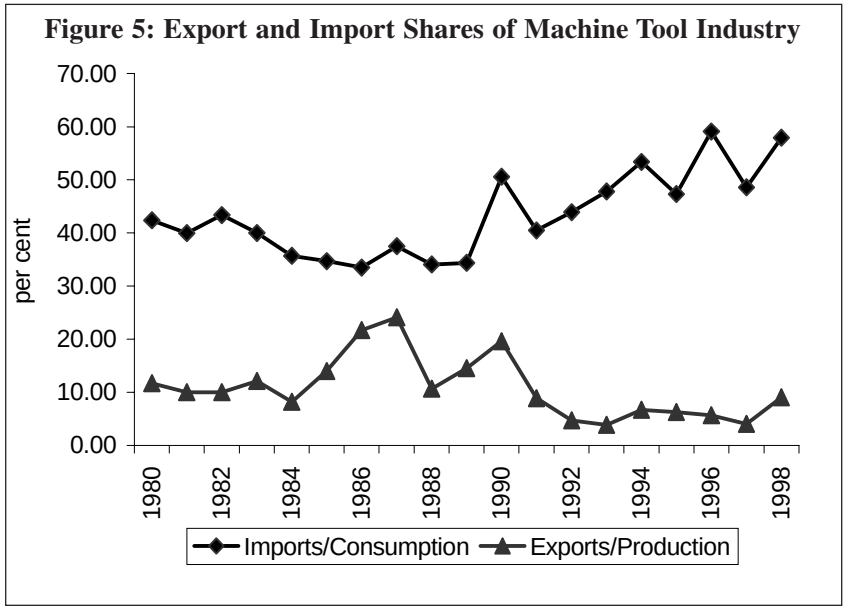
Despite the growth of the industry, the trends also reveal the significance of the contribution of imports to consumption. In 1951, imports represented 85 per cent of the value ofconsumption and the rapidly growing needs of industrialisation in the early years necessitated large imports of machine tools so that the share of imports in consumption was still 64 per cent in 1965. The deceleration in the industrial sector after 1966 led to not only a decline in the consumption of machine tools but also that of imports with the share of imports in consumption declining to 23 per cent in 1973. In 2002, imports still represented about 38 per cent of consumption.

As a result of liberalisation and delicensing measures introduced in the Indian economy, since the 1980s, domestic competition increased in the manufacturing sector and firms began to import machine tools. The setting up of large production capacity in the automobile sector with the entry of major global automobile companies also led to an increase in imports. Also, globally, there were technological changes, so that in many of the developed countries there was a rapid rise in the production and consumption of CNC machine tools as against conventional machine tools. In India too, there was thus a major qualitative change in the user industry specifications regarding their requirements for machine tools in the decade of the 1980s. In the course of their modernization efforts, the user industries of machine tools in India in the engineering sector in general and the automobile sector in particular began to insist on more sophisticated machine tools in terms of quality, design and capabilities. Given that the technological gap had widened between India and the global leaders in machine tools, the domestic industry had yet to establish the capability in the manufacture of CNC machine tools. While some established companies like HMT and Mysore Kirloskar produced CNC machines with foreign collaboration, at least, initially, the quality of CNC machines produced in the economy was not considered as comparable with international standards and moreover the range of CNC machines produced were limited. Domestic user industries therefore preferred to import these machines leading to a rise in imports. More than a thousand such machines were imported between 1980-85(Tulpule and Datta,1990).

The result of the long era of protection provided to domestic industry and the consequent absence of international competition in the machine tool industry meant that the industry lacked cost competitiveness. This was evident in the 1990s when the Indian economy was liberalized to a significant extent and quantitative restrictions on imports were removed, duties lowered substantially and liberal imports of second hand goods were permitted(see Table 8, Appendix). With easy availability of cheap imports from China, Taiwan and S.Korea, the Indian machine tool industry was forced to restructure in order to survive. The lack of price competitiveness led to the closure of many small enterprises. Even larger companies were affected by the liberalization in the economy and the industry. The largest machine tool company in India, HMT, suffered continuous losses since 1993-94 and was forced to undertake restructuring at different levels. Similarly the public sector Praga Tools has been suffering losses while one of the oldest and largest private sector company, Mysore Kirloskar faced closure. Only firms that recognized the rapid changes taking place in the market and responded adequately were able to survive and grow.

Exports of the machine tool industry are not significant and India's share in global exports of machine tools is a mere 0.2 per cent. The share of exports in domestic output, which was 17 per cent in 1978 declined to 11 per cent in 1988

Figure 5: Export and Import Shares of Machine Tool Industry



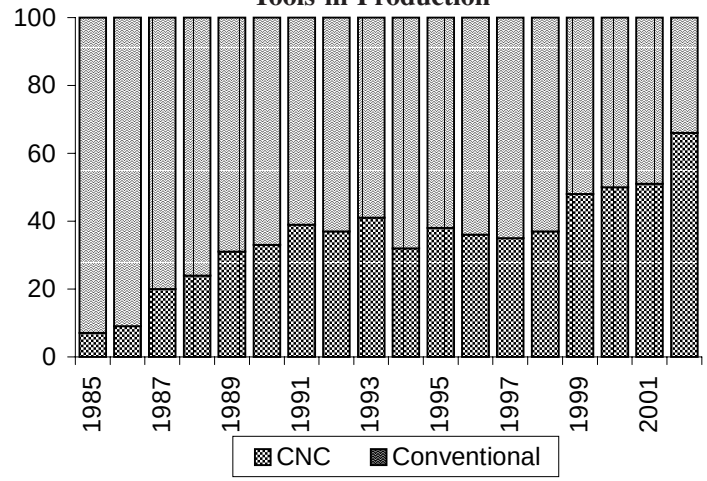
and was less than 10 per cent in 1998. During the 1990s India's exports of machine tools declined substantially. The major focus of the machine tool companies has been in establishing capacity to produce for the domestic market, which was protected until the 1990s. The machine tool industry thus had an inward –orientation and the industry lacked an export focus. Exports went mainly to the erstwhile USSR and the East European markets which had provided assured markets through bilateral agreements in the era of protection but with the internal transition and developments in those countries the export performance of the machine tool industry in the 1990s has not been very good.

The decline in the demand for conventional machines, which India was mainly exporting and the inability to produce standardized CNC machines with international quality and safety standards as well as stiff competition in global markets for these machines was one major reason. Moreover, India had for long been exporting primarily to its traditionally secure markets in the USSR and the East European countries. This situation changed in the 1990s when these traditional markets were no longer available. In 1986 for example, ten countries accounted for 92 per cent of total exports, with 75 per cent of exports going to just two countries namely, USSR and Bulgaria. By 1995-96 however, exports to OECD countries accounted for 37 per cent of total exports with the USA being the single largest destination(Matthews,1988, Uchikawa,1999).[18]

A significant feature of the growth of the machine tool industry in the 1990s is the increasing production of CNC machine tools and a decline in the share of conventional machines. In 1985, the share of CNC machine tools in total turnover was only 7 per cent. This share has increased rapidly to 51 per cent in 2001. In 2002, the estimated share of CNC machine tools is two-thirds while the provisional figure for 2003 is nearly 74 per cent(Appendix-Table 11).

Since increasingly the structure of production has changed globally in favour of CNC machine tools, the domestic industry realized the need for technological transformation. Thus the 1990s witnessed a major transformation in product orientation from conventional to CNC machines. From the mid-1980s a number of companies went in for technical collaborations for the production of a range of CNC machines with global majors like Mori Seiki, Siemens etc. A major reason for the rapid shift in product structure has been brought about by the liberalization in the user industries especially the automobile and automotive component industries.

Figure 6: Share of CNC and Conventional Machine Tools in Production



That the country is slowly establishing the capability to produce CNC machine tools competitively is also given by the increasing share of CNC machine tools in export earning of this sector. In terms of export earnings, CNC machines now account for forty per cent of the total export earnings and the country exports CNC lathes, machining centres, wire cut EDMs and Special Purpose Machines(SPMs).

In India, metal cutting machine tools forms nearly 80 per cent of the value of production of metal working machine tools, 76 per cent of export earnings and 74 per cent of value of imports. Lathes and automats, machining centres and SPMs are the three major items of domestic production accounting for 50 per cent of the value of metal working machine tools. Lathes and automats are the single largest item both in terms of numbers as well as in value, contributing to a quarter of the total value of metal working machine tools. Besides, EDMs, grinding and milling machines and gear cutting machines are other important items of production. In metal forming machine tools, presses are the single largest item of production followed by die casting machines.

In exports of machine tools, India has a competitive advantage in the export of lathes and automats, which accounted for 41 per cent of export earnings from metal working machine tools. EDMs and grinding machines are the other

important items of export earning. In the category of metal forming machine tools- presses are the single largest items of exports accounting for about 16 per cent of export earnings.

India imports mainly high technology and high value machine tools in which the domestic industry lacks technological know-how. Machining centres formed the single largest item of imports followed by lathes and automats, presses, grinding machines and gear cutting machines. Machining centres, lathes and automats and presses together accounted for 45 per cent of imports.

Some Major Issues in Strengthening International Competitiveness in the Machine Tool Industry – Results of Primary Survey

This section focuses on identifying key factors that can help strengthen international competitiveness of the machine tool industry based on qualitative response from firms in the industry. In the analysis of the determinants of export activity at the firm level, Kumar and Pradhan(2003b) focus on three sets of factors- firm specific factors, industry specific factors and policy inducements. In the case of the non-electrical machinery industry the study indicates the positive effect on exports of firm specific factors like age of the firm, imports of capital goods, firms expenses incurred on advertising and marketing, number of years a firm has been in foreign operation and foreign affiliation. Technological payments as per cent of sales has a negative effect while fiscal benefits provided by the government and liberalisation in general are shown to have a positive effect on exports.

The empirical results (Kumar and Pradhan,2003b) are reconciled with qualitative insights of this industry obtained through personal interviews with officials in industry bodies like IMTMA as well as CMTI and EEPCI and responses based on questionnaire from a sample of machine tools firms in Bangalore, Pune, Coimbatore and Hyderabad. The sample of firms chosen varied in size and ownership structure from large public sector to medium and small proprietor/partnership firms. A number of firm/industry related issues were rated by the respondents on a scale of 0 to 3-the responses indicating not important to most important. In order to understand the major issues the questionnaire had three sections relating to (a)general perception of the firm/industry status in relation to liberalisation; (b) technology related issues and (c) outward orientation and exports. The average response and coefficient of variation of the sample firms is given in Appendix-Tables 12 to 17. We now discuss these responses.

(a) Firm/Industry Status and Liberalisation:

The growth and development of the machine tool industry has been conditioned by government policies towards this sector. Until liberalization in the early 1990s, by and large, the industry was provided a protected environment under the import substitution strategy. Wide ranging liberalisation measures adopted since then have had a significant effect on the entire capital goods sector including the machine tool industry. While all quantitative restrictions on imports have been abolished, two measures have greatly affected this industry. Firstly, as part of rationalisation of the tariff structure, the government began a process of reduction in peak tariff rates with capital goods imports being subject to steep reductions in tariffs from over 100 per cent to 25 per cent. Secondly, imports of second hand capital goods have been permitted. Such imports are also permitted under the EPCG Scheme. After more than four decades of a protected environment, these measures had the effect of suddenly exposing the industry to international competition.

The qualitative responses from the sample firms to liberalisation measures varied significantly and can be summed up as follows:

- The major user industries for firms in the sample were automotive and autocomponent companies besides defence, railways and general engineering. For firms in the sample and for the industry in general, the auto and auto components sector in particular has emerged as a leading user industry with India emerging as a major global outsourcing hub for auto components.
- Moreover the consumer profile has changed with smaller and medium sized companies particularly in the auto components sector emerging as important consumers.
- Some of the fast growing firms in the sample felt that liberalisation which led to a lowering of tariffs had a positive effect on firms with import costs being reduced.
- Liberalisation has led to greater domestic competition and the positive outcome for the industry was greater customer orientation with new and improved products being offered by domestic firms to user industries.
- Public sector firms felt that liberalisation had hampered firms prospects with market share declining drastically particularly in low end products.
- Imports from Taiwan of low priced turning and machining centres, which are price sensitive segments greatly affected not only public sector firms but also some smaller to mid-size firms in the industry.
- On the other hand cheap second hand imports were not seen as a threat by firms included in the sample. However the general opinion was that such imports did affect smaller firms in the unorganised sector.
- Overall, the impact of liberalisation on business environment has seen a dramatic change with much greater competition. This has forced domestic firms into supplying better and faster machines with greater reliability and prompt delivery schedules. Lower prices(to an extent of 10-15 per cent) and enhanced productivity of the user industries were other outcomes of liberalisation.
- The industry is also witnessing changes in the market structure. While the share of public sector and big companies is declining, there has been a rapid growth of technocrat-owned mid-size companies with strong in-house design capabilities and lean management.
- Some firms indicated that with liberalisation in the economy and the changes in the business environment, they were more confidant of exploring export markets and while previously they did not consider exporting they were now actively looking at export markets particularly when domestic demand was sluggish.

Many firms in the industry however including the dominant producer in the public sector- HMT (as well as Praga Tools) have been affected greatly by the liberalisation process. This is clear from the data on firms profitability in Table 11 where profits after tax (pat) and profits before depreciation, interest and tax(pbdit) as per cent of sales for a sample of firms are given. The table clearly highlights the poor performance of the public sector and the financial problems faced in the context of liberalisation, increased competition, declining market share and the loss of export markets as well as internal factors within the firm.

In the private sector, one of the earliest companies to be set up and also a dominant producer in terms of market share - Mysore Kirloskar also faced closure. Mysore Kirloskar was set up in 1941 at Harihar and in time produced a wide range of machine tools emerging as a leading producer in the private sector. But with the management's inability to upgrade technology the firm faced a deep financial crisis and has since shut down (Mayya,2002).

(b)Technology Related Issues:

Links with user industries: A characteristic feature of machine tools is that they are often built to specific customer requirements in user industries. Machine tool builders frequently incorporate special features thus creating a 'niche'

Table 11: Trends in Profitability of Some Companies

(as per cent of sales)

Year	HMT		LMW		Widia		Electronica	
	pat	pbdit	pat	pbdit	pat	pbdit	pat	pbdit
1990	0.77	9.42	4.05	13.27	5.48	20.73	-	-
1991	1.81	10.25	3.72	12.18	5.45	22.01	-	-
1992	2.98	14.03	6.36	20.34	7.17	23.54	8.05	23.83
1993	0.37	13.36	7.70	22.00	6.38	22.29	7.40	24.47
1994	-18.53	-1.02	7.03	21.39	6.15	22.55	16.04	27.04
1995	-10.33	3.34	8.32	21.30	7.43	22.08	7.05	15.81
1996	-6.28	4.85	6.62	17.72	11.08	23.09	5.48	14.16
1997	-1.85	8.39	4.10	20.40	11.54	24.18	2.56	13.58
1998	-2.90	7.11	7.11	20.40	16.16	28.32	0.60	10.97
1999	-4.05	7.10	0.19	15.03	12.26	25.31	-6.54	5.80
2000	-39.19	-23.33	4.67	17.64	12.79	25.53	1.79	9.81
2001	6.84	24.28	5.31	17.38	10.31	21.27	2.30	10.99
2002	3.39	33.40	2.48	15.34	2.45	11.60	3.02	11.97

Source: Estimated from Prowess data, CMIE.

segment for their machines and thereby differentiating their products from those of other builders and hence competition. Moreover with the demand for machine tools having become more varied since the mid-1980s, customized-designing has become necessary to meet user demands. Close and continuous links need to be maintained with the user industries of machine tools for installation, commissioning, repair and maintenance as well as for supply of spare parts etc. The average response of sample firms on the nature of links with user industries is given in Table 12-Appendix. As expected, in all four respects firms felt that links with user industries was very important. After sales service and supply of spare parts to user industries are rated as being extremely important. In fact, some firms indicated that rather than simply supplying individual stand-alone machines they would prefer to offer total machining solutions to user industries. Retrofit packages i.e replacement of older machinery emerged as an important area of business with cost effective modernisation solutions being offered by some firms.

Other Technology Related Issues: The machine tool industry is an industry where engineering design rather than science based innovation plays a crucial role. R&D efforts are more oriented towards developing appropriate designs of customised machines for the user industry and increase in productivity rather than 'basic' R&D. Many firms in the sample had licence/technology agreements with firms in advanced countries. The public sector firms had a series of technology agreements, which ended with the firm assimilating technology. As in the case of HMT, many firms in the industry had technical collaborations with firms from developed countries involving the transfer of design and technology. As suggested in Kumar and Pradhan(2003b), this reliance on technology from abroad has led to conditionalities related to export markets and volumes. Given the wide technological gap between Indian firms and global market leaders in the industry, domestic firms find it more feasible to access the requisite technology from abroad rather than investing in what is called as 'reinventing the wheel'(Joseph,2003). Moreover given the low sales volumes of firms in India compared to large firms in developed countries, the resources available for R&D are felt to be insufficient for pursuing advanced research needed to be in the frontier. The data on foreign collaboration approvals in machine tools as given in Table 4 of the Appendix show an increase in the number of such approvals in mid-1980s indicating that a larger number of firms were seeking foreign collaborations for the manufacture of CNC machine tools to reduce the technology gap which had emerged.

For the firms in the survey, R&D expenditure as percentage of sales varied from slightly over 1 per cent to 5 per cent with the average R&D expenditure for the sample firms being 1.4 per cent. Imports of capital goods were however not significant with firms incurring expenditure only in certain years as and when occasioned. Imports of raw materials and components were however significant accounting for about 30 per cent to 40 per cent of sales.

On the technology issue, responses on four sets of issues were obtained through the questionnaire. The first set of issues relates to the decision of firms to start/increase R&D activity. The average response of the sample firms is given in Appendix-Table 13. Firms indicated the significance of R&D activity to improve competitiveness in the international market. Producing for global markets requires technological sophistication in many aspects which firms in the industry recognise. Given the greater degree of competition in domestic markets, R&D activity was considered as being important by firms to improve domestic competitiveness. Also, R&D activity was considered important to meet the changing requirements of user industries and to facilitate modernisation programmes in the user industries. Fiscal incentives in the form of tax incentives are however not a major consideration for determining the firms decision to start R&D activity.

The second set of issues relating to technology concerned the current focus of R&D activity of firms. Across all sample firms, it was universally agreed (Appendix-Table 14) that the current focus of R&D activity was on new design/product development and aimed at improving user industry productivity. This type of innovative activity involved incremental rather than basic design changes. Cost reduction measures relating to design changes and materials used were also considered as important focus of R&D activity. This was followed by R&D activity aimed at ensuring quality control– considered as crucial and significant for competing both in domestic and international markets. A major concern of most units, which outsource parts and components from smaller units, related to the lack of standardisation and quality standards in smaller units that ultimately affected the finish and quality of the final product.

The third set of issues regarding the development of technological capabilities in the machine tool industry related to the importance of industry bodies like IMTMA and government funded/supported institutions like CMTI

and DSIR. The IMTMA has contributed to awareness of technology issues through dissemination programs and the conduct of seminars etc. More important has been the role of the IMTMA Design Institute set up by IMTMA, which has contributed immensely (firms' response) to the enhancement of skill levels of technical personnel through its training programmes. The average response of firms is given in Table 15 of the Appendix. The CMTI is also regarded as having contributed significantly in providing machine and prototype testing services and technical information and perhaps more importantly through creation of human resources for entrepreneurship. Technocrat entrepreneurs who have been previously employed at CMTI today run some of the fastest growing firms in the industry(e.gACE Designers, Parishuddh Machines etc). The DSIR through its research support schemes was considered important by public sector firms in the sample. Co-operation among R&D units of different firms in the sample was not considered significant, although there is an ongoing collaborative effort of a couple of sample firms and CMTI for the development of indigenous CNC systems. The development of an indigenous low priced CNC system would enable the industry to be more competitive.

Finally the last set of issues in the section on technology related to the importance of government fiscal incentives, schemes and the role of public funded institutions like prototype development centres, tool room testing centres, etc. (Table 16-Appendix). These set of issues are not considered as important for firms in the sample as is evident from the responses. Among the three measures, R&D funding/subsidies was considered as more important relative to tax incentives or even the government provision of common infrastructural facilities. The firms in the sample were not responsive to government schemes, which it is felt are cumbersome, time consuming and ad hoc in nature. The lack of consistency of policies for fiscal incentives and the lengthy bureaucratic procedures were seen as deterrents in availing of schemes.

(c)Exports and Outward Orientation: The data from the machine tool industry confirms the results of the empirical study regarding the insignificance of exports as per cent of total production. Exports of this industry were a mere 6.9 per cent of production in 2001 with the average exports being only 4.7 per cent between 1992-97.

For firms included in the sample, exports were 10-15 per cent of sales. In fact, net exports of many firms in the industry are negative(Table 12). This is

mainly on account of the import of components and parts used in the manufacture of machine tools especially CNC machines. The major items of imports include CNC systems, ball screws and other high technology components like precision bearings, high frequency speed spindles and drives etc. These components are made only by a handful of manufactures mainly in Japan and Germany. Indian manufacturers are placed at a distinct cost disadvantage vis-à-vis manufacturers in countries like Taiwan which produce much larger volumes of machine tools and are therefore able to imports these components at more competitive (discounted) prices. The second aspect relating to imports of CNC systems is that often the latest technology systems are not available to Indian firms while Korean or Taiwanese firms have access to such technology leaving Indian firms at a disadvantage in international markets in terms of a technology gap.

The sample of firms were asked as to what factors were most significant in determining export competitiveness of firms. The response of the sample of firms is given in Appendix-Table 17. The most important factor identified by all firms for export competitiveness is price competitiveness. While in the pre liberalisation era, in the absence of competition, firms had no incentive to reduce costs the situation is very different now. Firms in the industry have been forced to restructure by improving efficiency and resource use. Ace Designers for example has reduced price of its small sized CNC lathe by 15 per cent and

Table 12: Trends in Net Exports of Some Machine Tool Companies

(Rs. million)

Year	Company				
	HMT	Praga	LMW	Widia	Electronica
1990	-505.0	-31.0	67.3	-19.5	-
1991	-674.8	-5.7	-25.8	-22.4	-
1992	-534.4	-21.7	-135.5	-31.3	12.8
1993	-460.2	-34.4	-159.4	-82.2	8.5
1994	-631.6	-0.5	-395.7	-5.3	17.8
1995	-366.6	-10.4	-418.9	-7.5	-9.2
1996	-540.9	-2.5	-906.8	-127.4	-31.3
1997	-432.3	0.7	-221.6	-197.3	-30.8
1998	-373.8	5.5	-455.9	-196.7	-15.0
1999	-340.0	-2.7	-362.9	-184.1	-21.7
2000	-405.5	-3.8	-93.7	-150.4	-44.2
2001	-31.7	-0.6	-194.9	-167.8	-35.1
2002	-28.7	-0.5	205.9	-198.7	-1.4

Source: Based on data from Prowess, CMIE.

introduced it as a new product with certain modifications. The result of this was that in two years, the demand for this CNC lathe tripled to 150 machines with the market still growing. The issue of price competitiveness is equally important for domestic as well as international competitiveness.

While price competitiveness is important, the issue is primarily that of supplying machines of superior quality at competitive prices. A major non-tariff barrier faced by exporters of machinery from developing countries relates to quality standards. In order to export, Indian machine tools must be built to international standards of quality, precision and reliability. The machines must satisfy the requirements of noise, safety standards etc of export markets. Many producers have in recent years acquired ISO certification. In recent years the industry has seen a move towards quality consciousness with more that two-thirds of the output coming from ISO certified companies. Manufacturers exporting to European countries also need CE Marking Certification. Acquisition of this certificate of quality however entails additional expenditure for the manufacturer in order to get the components/machine tested by recognised testing laboratories. Moreover, the time taken to get such certification adds to the uncertainties and delays in meeting export supply schedules.

Low labour costs in the economy are seen as an important factor contributing to export competitiveness. Although many firms in the sample felt that there was a shortage of skilled/experienced machinists in the industry and the turnover rate was high.

Established market and firm size were considered as being equally important. To export machines to international markets requires abilities beyond the scope of smaller firms. For smaller firms, it was felt safer to produce for a local market rather than exploring risky markets abroad. Building up firm reputation in the domestic market was perceived as important in penetrating export markets. The general impression is that the 'Made in India' brand has undergone a perceptible change in the last few years in overseas markets.

A major factor affecting competitiveness is the lack of global volumes in the domestic machine tool industry. For instance, while India manufactures only about 3000 GPMs China produces 300,000 and Taiwan 800,000 GPMs(EXIM Bank,2001). The industry needs to recognise that firms need to produce not only for the domestic market but also for the international market to gain from larger volumes and exploit economies of scale. Future growth of the industry will be determined by export performance(Shirgurkar,2001).

For export promotion purposes, export promotion councils like EEPCI and more importantly IMTMA are seen as playing an important role through ensuring participation in international exhibitions. Government fiscal incentives are however not considered as a very important factor determining firm's exports. While fiscal incentives for R&D were not considered important, those for promotion of exports were considered important but highly inadequate. Many firms suggested waiver of corporate tax on export earnings.

Among the general policy factors identified by firms as being important are the high incidence of taxation in India as compared to countries like Taiwan, the free entry of second hand capital goods and the anomaly in the import duty structure with CNC systems attracting the same import duty as complete machines. The high incidence of taxes totalling almost 37 per cent is often identified by many firms as a factor restricting growth of the industry. Taking all factors together, the industry feels that it faces a major competitive handicap in light of the free trade agreements signed with countries like Thailand and Singapore(Goindi,2004). Suggestions for industry competitiveness thus include a move over to a uniform value added tax, restrictions on the nature and entry of second hand imports and reducing duties on crucial imports of high technology components.

Our review of the machine tool industry has highlighted the effects of liberalisation on the industry. The pre reform period offered a protected environment and a major technology gap emerged. With liberalisation, firms in the industry including those in the public sector have witnessed major restructuring. In the context of WTO provisions, the current tariff rates may be lowered further while trade in second hand machinery is permissible. The industry thus needs to produce larger volumes as in countries like China and Taiwan to be competitive in international markets. The policy suggestions that emerge for strengthening international competitiveness in the machine tool industry are as follows:

- Track global technology change to ensure that technology gap does not emerge.
- Establish quality norms-like ISO 9000, CE Certification.
- Produce global volumes to exploit economies of scale.
- Focus on standardization of parts and components supplied by small units and strengthen supply chain management.
- Conduct market intelligence surveys to identify focus markets and products worldwide.

- Focus on image/brand building in both domestic and export markets.
- Establish global distribution/marketing networks, warehouse facilities for display etc.
- Utilize available R&D and export schemes-DSIR, UNDP,EEPCI etc.
- Encourage cluster programmes to share overheads in procurement, advertising etc and develop overseas links.
- Use of e-commerce for tapping new markets, e-sourcing, procurement, new vendor development etc.
- Institutional and policy support- modify indirect tax, lower duties on high-technology components, strengthen export infrastructure.

7. Summary and Key Strategic Initiatives to Strengthen International Competitiveness

Thus our study on non-electrical machinery industry shows the growth and diversification of the industry under the state led strategy of industrialization. The predominant role of the public sector in many of the machinery manufacturing segments contributed significantly to the achievement of the objective of self-reliance. The building of technological capabilities as well as the diffusion of such capabilities was also significant although the basic orientation of machinery manufacturers was production for the large domestic market. An outward export orientation was by and large found lacking. Liberalization measures including significant trade liberalization since 1991 affected some of the machinery segments adversely with imports rising significantly.

We now examine some strategic initiatives that can contribute to strengthening international competitiveness in the non-electrical machinery industry. The initiatives are broadly categorized into three groups - firm level initiatives, industry level initiatives and government initiatives.

Firm Level Initiatives: At the level of the firm there are a number of initiatives which need to be adopted in order for firms to take advantage of the new and extremely challenging as well as rapidly changing global environment and increase their prospects for growth as well as exports.

(a) Restructuring PSEs. A major aspect of future performance of the sector relates to the performance of PSEs in this industry. Since PSEs dominate segments of non-electrical machinery industry like machine tools, boiler manufacturing etc, there is a need to restructure and reorient these enterprises. Successful PSEs need to be encouraged to export more. With

possibility of privatisation of some of the PSEs the industry structure would change radically and affect development of this industry in future.

(b) Restructuring enterprises, promoting joint ventures etc. In case of firms in the corporate sector, restructuring of enterprises through mergers and acquisitions, promotion of joint ventures with foreign partners' etc is needed to enhance market position and acquire market leadership.

(c) Improve cost competitiveness. This can be done through improved internal controls, more efficient use of assets, streamlining vendor supply system, promoting sub-contracting and outsourcing of non-critical activities, etc. For larger firms, adoption of techno-managerial practices like JIT, TQM, TPM etc can improve efficiency and lower costs.

(d) Focus on technology upgradation. In India, in the non-electrical machinery industry, firm level innovation is low and most firms source technology from abroad. To be internationally competitive, firms need to adopt the latest product and design technologies. Larger firms in the industry need to allocate more resources for in-house R&D in product/design development.

(e) Need for upgrading quality standards. At the firm level, there is a need for firms to meet international quality standards and obtain ISO certification. Also firms need to acquire knowledge of quality standards for products in different export markets. Many exporters are often unaware of quality requirements necessary for their exports.

(f) Greater attention to marketing, brand building and customer service. Indian firms do not invest adequately in marketing activities and lack export thrust. Indian brand presence in engineering goods except for a few like Thermax for boilers, L&T for engineering and construction, HMT for machine tools is absent(Rao,1998). As the non-electrical machinery industry produces products, which need continuous support to user industries for maintenance, service, repair, supply of spare parts etc. there is a need to establish strong dealer/distribution network with strong customer support particularly in export markets.

Industry Level Initiatives: In the non-electrical machinery a number of industry level associations exist.

(a) Industry level associations like TMMA, IMTMA help in providing a common platform for problems and for interaction with government and other bodies. That their role is important is evident from the case study of machine tools.

(b) Research and training institutes promoted by industry level associations (e.g IMTMA Design Institute)are important since many small and medium firms lack the resources for in-house R&D and training facilities. Such institutes can therefore provide strong support to industry in meeting their requirements.

(c) Industry associations can also undertake market intelligence surveys to identify focus export markets, products and technologies etc. specific to that industry.

(d) Industry level associations can also play an active role in organising exhibitions, seminars etc both in India as well as abroad for dissemination of information, technology etc. and facilitate links with international associations in other countries.

(e) Industry associations can promote clusters particularly for SMEs and also strengthen links between large and smaller ancillary units.

Government Level Initiatives: In order to help the non-electrical machinery industry achieve overall export competitiveness, a number of government initiatives are imperative. Given the link between a favourable investment climate and its impact on total factor productivity (Viramani and Goldar,2004), government policy measure can contribute directly to improving various dimensions of investment climate.

(a) Rationalise indirect tax structure. This is necessary to reduce cost disadvantage to domestic machinery manufacturers. A shift to a uniform VAT would also reduce the incidence of multiple taxation and enhance price competitiveness in export markets.

(b) Reduce export transaction costs. As a first step, the source and quantum of transaction costs need to be identified. Procedural simplifications, automation and electronic processing of documents can reduce processing time and transaction costs.

(c) Facilitating export credit. Provision of export credit at internationally competitive rates to meet the pre- and post-shipment needs of machinery exporters is necessary. The EXIM bank can play a crucial role in ensuring adequate and competitive credit flow to firms engaged in exports.

(d) Strengthening export infrastructure. Domestic infrastructure is highly inadequate. Lack of proper roads, rail, and port and telecommunications facilities as well as shortages and unreliability of power are major supply side deterrents in achieving higher growth as well as increased exports.

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Endnotes

1. Non-electrical machinery in the study corresponds to two-digit ASI industry 35-Manufacture of Machinery and Equipment other than Transport Equipment.
2. Figures are from The Global Competitiveness Report,2002-03.
3. Shares of non-electrical machinery, tools and parts are taken from- Value of Output from Manufacturing-Registered at 1993-94 prices; NAS of India:1950-51-2000-01; EPW Research Foundation, Mumbai 2002.
4. See Appendix- Tables 1&2 for the classification according to NIC 1987 and NIC 1998.
5. Source of data base on output and employment is Annual Survey of Industries(ASI), CSO obtained from ASI:1973-74-1997-98-A Data Base on the Industrial Sector in India, EPW Research Foundation, Mumbai 2002. Data on output are at 1993-94 prices and obtained through use of appropriate, available deflators for the three digit classification. The data source for price deflators is Wholesale Price Indices, Ministry of Industry also available in EPW Research Foundation, Mumbai 2002.
6. Data on Indices of Industrial Production are at 1980-81 base and obtained from EPW Research Foundation, Mumbai 2002.
7. All growth rates in the study are trend growth rates estimated using semi-log trend given by : $\ln Y_t = \ln a + \ln b . t$
8. We have used the NIC 1987 classification and data from 1980-81 to 1997-98. ASI data are currently available for the next three years i.e upto 2000-01 based on the new classification of NIC 1998. It is difficult to establish concordance, even using the concordance table of NAS between the two classifications at the three digit level. We have therefore thought it fit to use the data only till 1997-98. At the two digit level, Balakrishnan and Suresh Babu(2003) are able to establish correspondence for 15 industries.
9. For the dummy variable test of significance the estimated equation is: $\ln Y_t = a + a'D + bt + b'Dt$ where D=0 for the pre reform period and D=1 for the post reform period.
10. The machine tool industry's aggregate growth of 2.27 per cent during 1980-81 to 1990-91 conceals the disparity in performance in the decade of the 1980s. The growth rate between 1980-81 to 1984-85 is 6.7 per cent as against 0.2 per cent for the period 1985-86 to 1990-91. On the other hand, in the case of textile industry the growth rate is 2.44 per cent for the period 1980-81 to 1984-85 and 14.14 per cent for the period 1985-86 to 1990-91.
11. Our estimate of 9.38 per cent is higher than the estimate of 8.5 per cent for Non-electrical Machinery(35) by Balakrishnan and Suresh Babu(2003). Since their estimate is for the period 1991-00, including the next two years would most likely lead to a lower growth rate.
12. Estimates of export and import shares are based on data from RBI.
13. Data on imports and exports are from CMIE, India Trades. Data are in US$ million. Categories 8471 and 8473 correspond to computers and their parts and accessories and hence were excluded in the analysis.
14. Within each category the four digit industries are arranged serial wise not according to value of share. Table 18 – Appendix gives the list of important four digit industries in exports and imports.
15. Appendix Table-5 lists the series of technology collaboration agreements that HMT had with global leaders for the manufacture of a variety of machine tools.
16. Machine tools are power driven machines used for metalworking i.e. metal cutting or metal forming. In India, metal cutting machines account for nearly 80 per cent of the value of metal working machine tools. The industry also produces parts and accessories for machine tools like tool holders, work holders, chucks etc; sophisticated parts like CNC systems, programmable logic controls etc. besides cutting tools and measuring equipment. The discussion in this section is based on data for metalworking machine tools obtained from IMTMA.
17. Data source is the World Machine Tool Output and Consumption Survey,2004,Gardner Publications Inc. Tables 6&7 of the Appendix are based on this data source.
18. Refer to Tables 9&10 of the Appendix.

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Appendix

Table 1: National Industrial Classification, NIC,1987

NIC Code 2 digit/3 digit	Description
35	Manuf. of Machinery and Equipment other than Transport Equipment
350	Manuf. of Agricultural Machinery and Equipment and Parts thereof
351	Manuf. of Machinery & Equipment used by Construction and Mining Industry
352	Manuf. of Prime Movers, Boilers, Steam Generating Plants and Nuclear Reactors
353	Manuf of Industrial Machinery for Food and Textile Industries including Bottling and Filling Machinery
354	Manuf. of Industrial Machinery except for Food and Textile Industry
355	Manuf. of Refrigerators, Airconditioners, and Fire Fighting Equipment and their Parts and Accessories
356	Manuf. of General Purpose Non-electrical Machinery/Equipment their Components and Accessories nec
357	Manuf. of Machine Tools, their Parts and Accessories
358	Manuf. of Office, Computing and Accounting Machinery and Parts
359	Manuf. of Special Purpose Machinery/Equipment, their Components and Accessories, nec
359.1	Manuf. of Sewing and Knitting machines
359.2	Manuf. of Weighing Machinery
359.3	Manuf. of Washing & Laundrying Machines
359.5	Manuf. of Filtering and Purifying Machinery for Liquids and Gases
359.6	Manuf. of Distilling and Rectifying Plants
359.8	Manuf. of Parts and Accessories nec
359.9	Manuf. of Special Purpose Non-electrical Machinery & Equipment nec

Table 2: National Industrial Classification,NIC,1998

NIC Code 3 digit/4 digit	Description
291	Manuf. of General Purpose Machinery
2911	Manuf. of Engines & Turbines except Aircraft, Vehicle and Cycle Engines
2912	Manuf. of Pumps, Compressors, Taps, Valves
2913	Manuf. of Bearings, Gears, Gearing and Driving Elements
2914	Manuf. of Ovens, Furnaces and Furnace Burners
2915	Manuf. of Lifting and Handling Equipment
2919	Manuf. of other General Purpose Machinery
292	Manuf. of Special Purpose Machinery
2921	Manuf. of Agricultural and Forestry Machinery
2922	Manuf. of Machine Tools
2923	Manuf. of Machinery for Metallurgy; Converters, Ingot Moulds, Ladles & Casting Machines; Metal Rolling Mills & Rolls for such Mills
2924	Manuf. of Machinery for Mining, Quarrying and Construction
2925	Manuf. of Machinery for Food, Beverage and Tobacco industry
2926	Manuf. of Machinery for Textile, Apparel and Leather Production
2927	Manuf. of Weapons and Ammunition
2928	Manuf. of other Special Purpose Machinery
2929	Manuf. of Domestic Appliances, nec
3000	Manuf. of Office, Accounting and Computing Machinery

Table3: Market Size and Share of Imports in Non-electrical Machinery, 1998-99

Industry	Market Size (Rs. crore)	Imports (%)
Non-electrical Machinery	31456.24	21.02
Printing Machinery	374.28	69.53
Textile Machinery	2272.83	67.91
Metallurgical Machinery	824.72	65.97
Pumps of all kinds	1400.42	42.35
Machine Tools	3759.30	38.82
Cranes	399.25	35.80
Steam and Hydro Turbines	885.15	32.45
Gears	626.04	31.20
Bearings	2248.60	27.53
Compressors of all types	1169.22	16.94
Material Handling Equipment	581.99	16.30
Agricultural Machinery	266.50	9.94
Engines of all types	2170.99	6.92
Boilers	1831.06	5.14
Earth moving machinery	2819.82	4.58
Sugar machinery	412.78	0.67
Cement Machinery	184.36	0.21

Source: CMIE, A Brief Overview of Market Size and Shares, August, 2000.

Table 4: Foreign Collaboration Approvals in Non-electrical Machinery:1976-2001

Year	Ind. Machinery	Mech. Engg.	Machine Tools	Total Approvals	(1)+(2)+(3) as % of Total Approvals
1976	57	13	19	277	32.13
1977	74	4	10	267	32.96
1978	76	7	20	307	33.55
1979	72	15	14	267	37.83
1980	121	29	26	526	33.46
1981	96	49	5	389	38.56
1982	110	125	6	588	40.99
1983	144	69	24	673	35.22
1984	169	99	27	740	39.86
1985	215	89	38	1041	32.85
1986	87	145	28	960	27.08
1987	165	83	24	903	30.12
1988	170	92	24	957	29.89
1989	74	75	11	639	25.04
1990	159	66	8	703	33.14
1991	191	92	12	976	30.23
1992	101	166	14	1520	18.49
1993	101	124	11	1476	15.99
1994	110	136	13	1854	13.97
1995	113	214	10	2337	14.42
1996	129	181	24	2303	14.50
1997	82	211	27	2325	13.76
1998	52	181	27	1786	14.56
1999	97	139	30	2224	11.96
2000	70	155	17	2144	11.29
2001	66	115	14	2270	8.59

Source:Foreign Collaborations(A Compilation: National Register of Foreign Collaborations),DSIR,Ministry of Science & Technology, 2001.

Table 5: List of Collaborations In Machine Tools ,HMT Limited

Year	Collaborator	Product
1949-66	Oerlikon, Switzerland	High Precision Centre Lathes
1957-63	Fritz Werner, FRG	Milling Machines(M2&M3)
1958-65	Hermann Kolb, FRG	Radial Drilling Machines(RM)
1959-66	Ernault Batignolles, France	Production Centre Lathes(LB)
1959-66	Olivette, Italy	Cylindrical Grinding machines
1961-71	Limex, GDR	Hydraulic Surface Grinding Machines (SFW)
1961-68	Renault, France	SPMs
1963-70	Drumond Brothers, UK	Gear Shapers (Maricut 2A & 3A)
1963-70	Fritz Werner, FRG	Milling Machines (Elect. Cont.)
1964-74	Haut Rihn, France	Single Spindle Automatics
1964-71	Liebherr, FRG	Gear Hobbing Machines(L Series)
1966-74	Gildemeister, FRG	Multispindle Bar and Chucking Automatics.
1966-74	Haut Rhin, France	Single Spindle Automatics
1966-77	Ernault Somua, France	Copying Lathes (S. Pilote)
1966-71	Jones&Lamson Div. Waterbury Farrel, USA	FAY Automatic Lathes
1966-71	Gildemeister, FRG	Drum Type Turret Lathes
1967-72	Pegard, Belgium	Horizontal Boring Machine
1967-77	Oswald Forst, FRG	Broaching Machines-H, V (I&E)
1968-73	Fin Motil, Switzerland	Clamping Chucks
1969-79	Interfonda, Switzerland	Diecasting and Plastic Injection Moulding Machines
1969-76	Ateliers GSP, France	Drilling and Boring Machines
1969-79	Verson, USA	Presses-Hydraulic and Mech.
1970-77	Fritz Werner, FRG	Ram Bed Type Milling Machines
1969-74	Oerlikon, Switzerland	Multipurpose lathes (DA)
1970-75	American Tool Works, USA	Heavy Duty Engine Lathes & Machining Centres for Drilling, Milling and Boring Operations
1971-78	Petermann, Switzerland	Sliding Headstock Automatics
1971-78	Fritz Werner, FRG	Unit Assembled Bed Type Milling Machines
1976-79	Cross, USA	SPMs and gear chamfering machines.
1979-87	Laeis Werke, FRG	Refractory Presses
1980-87	Pegard, Belgium	Horizontal Boring Machines
1982	Interfonda, Switzerland	Diecasting Dies
1981-89	Reifenhauser,FRG	Plastic Extrusion Machines
1982-89	Verson, USA	Low Cost Presses
1982-90	Oswald Forst, FRG	Surface Broaching Machines
1983-91	Liebherr, FRG	Heavy Duty Gear Hobbers
1983-91	Liebherr, FRG	High Speed Gear Shapers (WS 1)
1983-91	KTM, UK	CNC Machining Centres
1984-90	CZJ,FRG	Ballscrews
1984-92	Gildemeister, FRG	Multispindle Automatics (GF, GS)
1984-94	Siemens, FRG	CNC Systems
1985-93	Buderus,FRG	Precision Internal Grinding Machines
1986-91	Gildemeister, FRG	GDM Series Chuckers

Source: List of collaborations provided by HMT Limited, Bangalore.

Table 6: Production and Consumption of Metal Working Machine Tools

(in US $ millions)

Country	Production		Consumption	
	2003*	2002	2003*	2002
Japan	7861.6	6076.9	4109.2	3218.4
Germany	7525.2	6989.5	4372.8	4392.1
Italy	4180.7	3770.9	3293.7	3185.6
China	2910.0	2350.0	6580.0	5190.0
United States	2210.0	2306.0	3899.0	3844.0
Taiwan	2064.0	1775.4	1142.4	1028.9
South Korea	2059.0	1587.0	2766.0	1960.0
Switzerland	1736.4	1824.7	537.1	599.2
India	150.3	106.5	277.0	185.1

Source: Gardner Publications Inc., 2004.

Table 7: Exports, Imports and Trade Balance of Metal Working Machine Tools

(in US $ millions)

Country	Exports		as % of production	Imports		as % of consumption	Trade Balance	
	2003*	2002	2003	2003*	2002	2003	2003*	2002
Germany	4756.9	4169.0	63%	1604.5	1571.6	37%	3152.5	2597.4
Japan	4131.6	3170.3	53%	379.3	311.7	9%	3752.3	2858.5
Italy	1926.5	1727.8	46%	1039.5	1142.5	32%	887.0	585.4
Taiwan	1651.2	1453.1	80%	729.7	706.6	64%	921.5	746.5
Switzerland	1527.3	1561.8	88%	328.1	336.3	61%	1199.2	1225.5
United States	889.0	959.0	40%	2578.0	2497.0	66%	-1689.0	-1538.0
China	370.0	310.0	13%	4040.0	3150.0	61%	-3670.0	-2840.0
India	12.9	10.5	9%	139.6	89.1	50%	-126.7	-78.7

Source: Gardner Publications Inc.

Table 8: Imports of Machine Tools: New and Second-hand

Year	New		Second Hand/Used		Used as % of new (quantity)	Used as as % of new (value)
	No. of units	Value (Rs.million)	No. of units	Value (Rs.million)		
1994-95	1944	3557	287	234	16	7
1995-96	3222	5079	967	897	30	18
1996-97	3667	10311	869	1146	24	11
1997-98	2817	6727	833	1313	30	20
1998-99	3561	8146	725	797	20	10
1998-99	1379	4742	175	159	13	3.4

Source: EXIM Bank,2001 based on IMTMA data.

Table 9: Exports of Machine Tools by Destination, 1986

(Rs.million)

Country	Value of Exports
USSR	192
Bulgaria	178
West Germany	47
USA	26
Iran	17
Algeria	9
Canada	8
UK	7
Australia	4
Sweden	3

Source: Matthews(1988);based on IMTMA data.

Table10 Exports of Machine Tools by Destination,1995-96

(Rs.million)

Country	Value of Exports	Per cent of Total Exports
USA	53.4	11.4
Russia	29.1	6.2
Germany	27.1	5.8
UAE	22.7	4.8
Kenya	21.9	4.7
South Africa	20.2	4.3
OECD	174.4	37.1
Total	470.4	100.0

Source: Uchikawa(1999); based on IMTMA data.

Table 11: Production and Share of Metal Working CNC Machine Tools

Year	Quantity (Nos.)	Value (Rs.million)	Share of CNC in total turnover (per cent)
1985	65	128.6	6.6
1986	93	174.8	9.0
1987	200	478.8	19.5
1988	282	671.8	24.4
1989	462	1054.2	31.1
1990	560	1368.7	33.1
1991	680	1824.9	36.2
1992	513	1862.0	37.3
1993	425	1715.0	41.7
1994	717	2627.7	43.9
1995	949	2708.8	37.6
1996	1050	3179.0	39.3
1997	1038	3160.0	39.7
1998	1000	2480.0	36.9
1999	1220	2843.0	47.6
2000	1382	3183.0	50.5
2001	1235	2711.0	51.0
2002	1655	3204.0	66.0
2003[P]	2218	4386.0	74.0

Source: based on IMTMA data.

Primary Survey Responses of Machine Tool Firms- Tables 12 to 17

Table 12: Importance of Links with User Industries

Query	Average response	cv(%)
After sales service	3.00	0
Supply of spare parts	2.88	11.5
Customised machine tools	2.63	26.5
Training	2.25	36.9

Table 13: Major Reasons for Engaging in R&D Activity

Query	Average response	cv(%)
Improving competitiveness in international markets	2.88	11.5
Improving competitiveness in domestic markets	2.63	26.5
Changing profile of consumer demand	2.34	46.7
Improvement of existing technology	1.50	81.7
Unavailability of technology	1.50	74.5
Restrictions on technology imports	1.50	185.6
Tax incentives	0.50	200

Table 14: Current Focus of R&D Activity

Query	Average response	cv(%)
New design development	3.00	0
New product development	3.00	0
Improving user industry productivity	3.00	0
Cost reductions	2.88	11.5
Quality control	2.75	15.7
New process development	1.63	74.9
Adaptation of imported technology	1.63	68.4
Diversification	1.00	132.3

Table 15: Importance of Links with R&D Institutions

Query	Average response	cv(%)
Links with IMTMA,IMTMA-DI	2.88	11.5
Links with CMTI,DSIR etc	1.63	81.1
Links with R&D units of other firms	0.13	264.6
Links with R&D units of parent organisation	0.13	264.6

Table 16: Importance of Government Incentives

Query	Average response	cv(%)
R&D fundings,subsidies etc.	1.13	95.9
Tax incentives	1.00	122.5
Public funded infrastructure like tool room testing centres etc.	0.13	264.6

Table 17: Relative Importance of Different Factors for Export Competitiveness

Query	Average response	cv(%)
Price competitiveness	3.00	0
Low labour costs	2.34	36.1
Established market	2.25	19.3
Firm size	2.13	43.6
Industry Associations(IMTMA)	2.00	50
Availability of design/skill manpower	2.00	43.3
Export promotion councils	1.88	62.2
Technology institutions	1.50	74.5
Advertising/marketing measures	1.50	57.7

Table 18: Important Categories of Trade in Non-electrical Machinery

Four-digit ITC code		Industry
8407	-	Spark ignition, reciprocating/rotary IC engines
8408	-	Compression-ignition internal combustion piston engines
8409	-	Parts solely/principally for engines of 8407-8408
8411	-	Turbo-jets, turbo propellers and other gas turbines
8413	-	Pumps for liquids
8414	-	Air/vacuum pumps, compressors, etc.
8419	-	Machinery, plant lab. equipment for heating, cooking, etc.
8431	-	Parts suitable for use with machinery of 8425-8430
8443	-	Printing machinery
8445	-	Mach. for preparing textile fabrics for spinning, twisting etc.
8446	-	Weaving machines/looms
8448	-	Auxiliary machinery and parts and accessories for textile machinery
8452	-	Sewing machines, needles, etc.
8466	-	Parts and accessories for machine tools
8477	-	Machinery for working with rubber/plastic
8479	-	Machines/mech.appliances for specific use, nes
8481	-	Taps, cocks, valves, etc.
8482	-	Ball or roller bearings
8483	-	Transmission shafts and cranks, gears, ball screws, bearing housing, etc.

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